DOCUMENT RESUME

ED 152 467		RC 010 438

TITLE	Retention of Minority Students in Engineering. A Report of the Retention Task Force, Committee on Minorities in Engineering, Assembly of Engineering, National Research Council.
INSTITUTION	National Academy of Sciences-National Research Council, Washington, D.C. Committee on Minorities in Engineering
PUB DATE	77
NOTE	113p.
EDRS PRICE	MF-$0.83 HC-$6.01 Plus Postage.
DESCRIPTORS	Admission (School); American Indians; Ancillary Services; Black Students; College Preparation; Counseling Services; *Dropout Prevention; *Engineering; *Enrollment Influences; Higher Education; Mexican Americans; *Minority Groups; Models; Program Improvement; Puerto Ricans; Questionnaires; *School Holding Power; Student Organizations; Student Recruitment; Tutoring; Work Experience Programs

ABSTRACT

During 1975 questionnaires requesting the retention rates of both minority students and the total student population were sent to 200 engineering colleges which had the largest minority enrollments in 1974. Only 30 schools responded with useful information. Another lengthier questionnaire was sent to 71 of the original 200 schools requesting the opinions of those most responsible for minority programs, information about programs and services, and statistical data. Of these, 31 schools responded. Also visits were made to 29 engineering campuses with active programs to increase minority student enrollment. Some findings were that insufficient preparation in mathematics and the physical sciences, inadequate motivation toward engineering as a career choice, lack of adequate financial resources, and absence of self-confidence were the most common reasons for attrition among minority engineering students; there was a need for larger numbers of Hispanic faculty and staff at engineering colleges where Hispanics number about half of the total population; and the amount of personal contact among students, faculty, and staff was an important variable in a retention program. Among the recommendations were that successful precollege academic programs be continued and expanded to increase the academic skills of the underprepared students who have a keen interest in engineering; able minority juniors and seniors and/or graduate students should be identified to tutor other students. (NQ)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED152467

APR 1978
ERIC / CRESS
RECEIVED

Retention of Minority Students in Engineering

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

LeVoy Spooner

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

Committee on Minorities in Engineering

Assembly of Engineering

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

RC 010438

Retention of Minority Students in Engineering

A Report of the
Retention Task Force

Committee on Minorities in Engineering
Assembly of Engineering
National Research Council

NATIONAL ACADEMY OF SCIENCES
Washington, D. C. 1977

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the Committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

Copies of this publication are available from:
Committee on Minorities in Engineering
National Research Council
2101 Constitution Avenue
Washington, D.C. 20418

TASK FORCE ON RETENTION

WILLIAM P. ABBOTT, Test Officer, Counseling and Testing Office, California State College, Long Beach

L. BRYCE ANDERSEN, Professor of Chemical Engineering, New Jersey Institute of Technology

ALEXANDER T. ASTIN, Professor of Social Psychology, Graduate School of Education, University of California, Los Angeles

PEPE BARRON, Executive Director, El Congreso Nacional de Asuntos Colegials

HENRY J. CASSO, President, The National Institute for Professional Development

ROBERT FOSTER, Professor of Engineering, Pennsylvania State University

PATRICIA HEARD, Coordinator-Learning Services, Reading and Study Skills Laboratory, University of Texas at Austin

WILLIAM E. HOGAN, (*Chairman*), Associate Dean, College of Engineering, University of Kansas

MONTE E. JACOBY, Director, College Relations and Support, Olin Corporation

WILLIAM K. LEBOLD, Professor of Engineering, Purdue University

SHIRLEY MCBAY, Director, Minority Institutions Science Improvement Program, National Science Foundation

ANNE MONTERIO, Director for Minority Programs and Administrator for the Interdisciplinary Programs, College of Engineering, University of Michigan, Ann Arbor

LOUIS PADULO, Dean, College of Engineering, Boston University

JAMES ROSSER. Vice Chancellor, Department of Higher Education, Trenton, New Jersey

HORACE ST. JULIEN, Acting Chairman, Electrical Engineering, Prairie View A&M University

Staff

LAVOY SPOONER, Assistant Director, Committee on Minorities in Engineering

Foreword

In recent years, equal opportunity for all has become a dominant precept in U.S. society. Progress has been made in some areas by those minority groups who have been particularly discriminated against in the past and, as a result, have been underrepresented in the nation's economic, cultural, and educational life. Even so, those minorities—blacks, Mexican-Americans, Puerto Ricans, and American Indians—have not yet experienced a general expansion of opportunity to participate in professional and higher education, especially in engineering.

One of the first studies of this problem was conducted under the auspices of the Sloan Foundation. The report of this study, *Minorities in Engineering: A Blueprint for Action,* published in 1974, called on the National Academy of Engineering to "assume a leadership role in coordinating the efforts of the many organizations working to increase minorities in engineering and in stimulating development of new programs that may be needed nationally."

As it happened, the National Academy of Engineering (NAE) had held a symposium, more than a year earlier, at which some 250 engineers, educators, and university and industrial leaders had agreed unanimously to set a national goal of increasing the number of minority engineering students tenfold within a decade. The goal of bringing more qualified and motivated minority students into engineering education was to be directed at benefiting young men and women from the four underrepresented minorities without necessarily displacing any other students.

In April 1974, the NAE established the Committee on Minorities in Engineering to, among its many purposes, examine the problems and needs to identify, recruit, prepare, and assist minority students for engineering education. It has been clear to the committee that two basic

p. iv blank

factors contribute to the underrepresentation of minorities in engineering: (1) the relatively small number or minority youth who are prepared academically and motivated psychologically (and socially) for an engineering education and (2) the high attrition rate of minority students in engineering schools.

Thus, the long-range task for increasing the representation of minorities in the engineering profession requires a significant expansion in the number of prepared and motivated minority students. The short-term task centers on the critical need to lower the rate of dropouts for members of minorities in engineering schools.

Since the NAE's meeting in 1973, total minority freshman enrollment in engineering has increased from 2,905 to an estimated 7,500 in 1977. While not enough time has passed to get a clear picture of the graduation record, by contrast with minority freshmen the number of minorities earning engineering degrees is low indeed. Consider that the number of black graduates has increased from 756 in 1974 to 833 in 1977, the number of Hispanic graduates from 640 in 1974 to 712 in 1977, and American Indians from 32 in 1974 to 35 in 1977. The statistics are a sobering reminder that cultural and educational changes cannot be achieved rapidly.

Those of us close to the education of minorities in engineering know that retention is a fundamental issue. The causes of the high rate of attrition among minority students in engineering need to be more clearly understood before cures can be prescribed. Only now is there a large enough number of minority students in engineering schools to provide an adequate data base for studies of retention. It is probably premature to expect any comprehensive studies, and the one undertaken by the Committee on Minorities in Engineering (now part of the Assembly of Engineering of the National Research Council) does not lay claim to being comprehensive or definitive. It is a necessary beginning. It offers information and insights that are likely to accelerate changes and improvements in minority programs that may significantly affect student retention in engineering schools.

Retention is a critical problem for all engineering students, not only for those of minority extractions. In this sense, the report of the Committee's Task Force on Retention may be useful in a more general way.

The Task Force realizes that the dynamics of retention rates have been affected by, but have not been limited to, the following factors:

- Minority enrollments have been increasing since the early 1960's.
- Minority engineering programs have been progressing since 1967.

- National minority engineering efforts have been developing since 1973.
- For all students, standardized test scores have decreased, while grade point averages have apparently increased.

Moreover, while the Task Force encountered some difficulty in obtaining accurate, authoritative retention data, the data in this report cover some 40 percent of all minority students enrolled in accredited engineering schools. Despite some obvious limitations in the validity of the data and the complete understanding of the retention problem, the Task Force holds that its report will benefit the minority programs in engineering schools, corporations, and foundations concerned with enlarging the opportunities of minorities in engineering education and organizations of minority groups seeking more affirmative ways of advancing minority participation in the mainstream of the country.

The Task Force wishes to thank the staff of the Committee on Minorities in Engineering and the directors and staffs of the engineering schools who have responded to its request for data, even when it meant doing the necessary research on material not readily available.

William E. Hogan II
Chairman, Retention Task Force
Associate Dean, College of Engineering, University of Kansas

Preface

The Committee on Minorities in Engineering established its Retention Task Force in November 1975 to examine the causes of the high rate of attrition among minority students in engineering schools and to help improve the efforts to increase the opportunities for black, Mexican-American, Puerto Rican, and American Indian students to enter and complete engineering education.

As the study progressed, the Task Force became aware that the lack of accurate data on the retention of minorities in engineering schools limited its ability to accurately evaluate the problem. Therefore, to conduct its study, the Task Force decided to adopt a parallel approach: to gather new data through a survey of engineering schools and to collect the observations of the minority program directors in those schools. In this way the Task Force sought to make up for the absence of published national studies on the retention of minority engineering students.

Questionnaires requesting the retention rates of both the minority students and the total population of students were sent to 200 of the 282 engineering colleges with the largest minority enrollments in the school year 1974. Of the 200, only 30 schools responded with useful information. Then another, lengthier questionnaire, requesting information about programs and services, as well as statistical data, was mailed to 71 of the originally surveyed schools, which, taken together, enroll 80 percent of the total number of minorities in engineering. Beyond the retention statistics, the questionnaire asked for the opinions of the people most responsible for minority programs at each college. This time, 33 of the 71 schools returned the questionnaire. The minority students at the 33 schools represented more than 40 percent of the total reported minority students in engineering education during 1975. In

p. viii blank

addition, visits were made to 29 of the engineering campuses where there were active programs to increase the enrollment of minority students.

As the data began flowing in, it became apparent that institutional information on the causes of attrition and rates of retention were either incomplete or nonexistent. Some of the colleges reported that they could not supply information on student progress, the number of students on academic probation and warning, or the record of dropouts and transfers for minority students, because they did not keep such data. Many colleges also could not report such information on their total student bodies. On its own, however, the Task Force has collected much meaningful information from the schools, and it is pleased to present this in the following report.

Contents

SUMMARY AND RECOMMENDATIONS 1

INTRODUCTION 10

THE RETENTION PROBLEM 17

RETENTION PROGRAM COMPONENTS 33
- PRECOLLEGE PROGRAMS 33
- RECRUITING AND ADMISSIONS 39
- CURRICULUM FEATURES 45
- TUTORING 53
- ADVISING AND COUNSELING 56
- MINORITY STUDENT ORGANIZATIONS 58
- FACULTY INVOLVEMENT 60
- PART-TIME/CO-OP WORK EXPERIENCES 62

RETENTION PROGRAM MODELS 65

FUTURE STUDIES 79

REFERENCES 82

APPENDIX

A SURVEY OF MINORITY ENGINEERING RETENTION PROGRAMS 84

B QUESTIONNAIRE B. STUDY OF PROGRAMS FOR THE RETENTION OF MINORITY STUDENTS IN ENGINEERING EDUCATION 86

TABLES

1 Retention of Engineering Students
2 Average Year-to-Year Retention Rates, 1970–1974
3 Retention of Minority Engineering Students in Public and Private Schools
4 Significant Retention Factors Rank Ordered by 31 Engineering Colleges
5 Rank Order Listing of Factors that Impact Upon Minority Student Retention
6 1976 Freshman Engineering Student Declaration of Need for Remedial Work
7 Average High School Grades of 1976 Entering Engineering Students
8 Retention Program Components
9 Prefreshmen Summer Programs
10 Learning Support Programs
11 Percentage of Minority Students with Reduced Course Loads, 1975–1976

FIGURES

1 Enrollments of Underrepresented Minority Students, 1969–1977
2 Bachelors and Masters Engineering Degrees Earned by Minorities, 1969–1977
3 Minority Engineering Program Cost Per Student
4 Average Cost of Minority Engineering Programs, Public and Private Institutions

Summary and Recommendations

In the late 1960's and early 1970's, largely in response to federal affirmative action programs, many engineering colleges, like most of the country's professional schools, accepted almost any minority applicant they could find, with little regard for ability or training. This often led to failures and dropouts, mainly in the first year. One unintended result of this "revolving-door syndrome" is frustration, apathy, or hostility among young members of minority groups who aspire to careers in engineering.

Beyond the perverse effects that attrition has on the expectations and confidence of minorities, it takes a toll in "human capital." Often underprivileged and always underrepresented, Americans from minority backgrounds have contributed greatly to the nation's social, technical, and economic life. One of the professions that offers a significant opportunity for affecting the mainstream of American life today is engineering, which has always had an attraction to members of minority and ethnic immigrant groups as a major step in their economic and social advancement.

In the last four years, even as the proportion of minority students in such professional schools as law and medicine has leveled off, or dropped in some cases, the number of minority students in engineering continues to increase. Despite this, the Engineering Manpower Commission of the Engineers Joint Council reports a persistent disparity between freshmen enrollment and graduation figures among minorities in engineering schools.

Data collected by the Commission show that in 1973 there were 2,905 full-time freshman engineering students from four particularly underrepresented minorities—blacks, Mexican-Americans, Puerto Ricans, and American Indians. Its surveys of the nation's engineering schools found that 1,580 minority students had received B.S. degrees in June 1977. For all engineering students, by contrast, the Commission put the number of full-time freshmen at 51,920 in 1973 and the total of graduates at 40,340 in June 1977. It does not follow that retention rates can be calculated simply on such numbers. The total of graduates, whether for all students or for minorities only, includes not only full-time engineering students but transfers from such other fields as physics and chemistry, from co-op and stretch-out sequences, and from part-time and extension programs. Thus, the graduation rate for all students is 77.8 percent, while for minorities in engineering it is 54.8 percent—a critical difference of 23.3 percent.

In its latest assessment of freshmen in engineering, based on a cross-section of U.S. schools, the Commission estimates that the total enrollment for the fall 1977 class is about 87,300. The estimate for the four groups of minority students in engineering is about 7,500, with blacks showing an 18 percent increase and Spanish-surnamed students up nearly 31 percent over the previous fall. Such statistics indicate that progress is being made toward the "target" of a tenfold increase in minority engineering students by 1982, when freshmen enrollment should reach 13,500. With minority freshmen enrollment at 7,500 in fall 1977, the program to recruit prospective minority engineers is halfway to its 10-year goal.

But that is only half of the problem. To fulfill the goal of achieving a representation approaching the proportion of the nation's minority population, the percentage of minority engineers, now only 2 percent of the total of 1,072,000 practicing engineers in the United States, will need to rise ultimately some sevenfold. One critical problem in attaining that goal is the high dropout rate for minority students in engineering. Between now and 1982 the retention rate of minority students will have to improve substantially. Clearly, as more qualified and motivated minority students enter engineering schools, their survival rate is bound to go up. Even so, much more needs to be known about the retention factor for minorities in engineering education.

This study deals with the causes of the high attrition rate among minorities in engineering colleges and recommends certain actions that are considered important in correcting the current disparity between enrollment and graduation. In the course of the study, the Task Force found:

- Insufficient preparation in mathematics and the physical sciences is one of the two most common reasons for attrition among minority engineering students. As a group, minority students have a lower quality of preparation than their nonminority peers in the crucial engineering prerequisite courses. Precollege programs appear to be effective in helping to fill the voids in the prior academic preparation of minority students and in developing more sophisticated students who are better equipped to withstand the rigorous demands of engineering.

- Inadequate motivation toward engineering as a career choice is the second most important retention factor for minority engineering students. Many minority students who enter engineering colleges have only a vague knowledge of the demands of an engineering education and the available professional opportunities. The absence of a strong commitment to engineering appears to contribute to a weak resolve to the exacting work and discipline of an engineering curriculum and a tendency to gravitate to a less demanding field of study.
- Lack of adequate financial resources is another major cause of attrition among minority students. This problem manifests itself in two ways. Not only can the lack of money to pay tuition and other expenses lead to attrition, but the anxiety associated with money problems or excessive amounts of time spent working to earn money to pay educational expenses can lead to poor academic performance.
- Absence of self-confidence is an important factor in the retention of minority students and is closely related to preparation in math and science. An inordinate number of unsuccessful academic experiences can undermine an individual's self-confidence and contribute to self-doubt about one's ability to compete in an engineering program.
- Personal and/or family problems of minority students often interfere with academic performance. Because most minority students come from lower socioeconomic backgrounds than their nonminority peers, the resulting anxieties create a great distraction from academic pursuits. If the social condition and life style of a student on campus are significantly different from those experienced at home, the additional adjustment pressures can interfere with academic performance. Some minority students at predominantly white colleges tend to minimize their interaction with their nonminority peers. Such self-segregation contributes to feelings of alienation and isolation, which are characteristic of students who are prone to drop out of engineering schools.
- Excessive expenditures of time for social and nonacademic student activities, by contrast, can sometimes demand too much of a student's time and lead to neglect of studies. However, minority engineering student organizations appear to have a positive impact upon the retention of their members. The organizations appear to offer structured mechanisms through which their members gain professional identity and peer support.

RETENTION PROGRAMS

Minority engineering programs that show improvements in the retention rates usually have the following general characteristics:

- Broad-based and many-faceted, these programs possess well-integrated and coordinated components. They provide a variety of services and are better able to answer the many varied needs of a diverse student body. Each program has at least one dedicated, competent, aggressive staff or faculty member who devotes considerable time to the program.
- Such programs are constantly evolving, though mature programs do not change radically from year to year. The successes and failures of previous years are used to modify program components in order to serve the needs of a changing student body and changing institutional experience, based on dealings with minority students.
- The programs operating within the engineering colleges are generally more effective than university-based programs in providing career guidance, academic counsel, tutoring, and similar services. However, university-based programs are generally better prepared to offer personal and financial aid counseling, as well as courses in reading, study, and test-taking skills.
- Effective personal counseling is an important component of retention programs. Such counseling can help the underprepared students cope with the anxieties that may arise from the stress of difficult academic and social adjustments. Effective counseling appears to be a greater need at the predominantly white private colleges than the black colleges. At the predominantly white colleges, minority program staff members provide the most effective counseling.
- Minority upperclassmen contribute the most effective tutoring for minority freshmen and sophomores at most colleges. When such tutors are paid by the college rather than serve in a voluntary capacity, better results are obtained.
- Adequate staffing can be an important factor in the effectiveness of the program and also an indication of institutional commitment. Some engineering colleges have only a part-time director, while others have as many as three or more full-time staff members. The programs with the larger staffs are generally more comprehensive and effective than those with a part-time person.
- Most of the predominantly black engineering colleges have a critical need for larger staffs. At those schools, the dean's staff is small and required to perform many duties. Effective utilization of additional

staff persons to assist in the administrative, tutoring, and counseling responsibilities are likely to improve the academic support services.

- In those southwestern states where Hispanics number about half of the total population, a need exists for larger numbers of Hispanic faculty and staff at engineering colleges to serve as role models, provide academic support services, and recruit more minority students.
- The amount of personal contact among students, faculty, and staff is an important variable in a retention program. The more time that is spent with students by college representatives, and the richer the quality of that interaction, the more successful the minority students have been found to be in the engineering program.
- Retention programs should be flexible enough to meet the particular needs of individual students. Minority engineering students, like most other groups of individuals, have broadly varying needs and abilities. Not all minority students need remedial work, not all minority students are poor, and not all minority students want to be singled out for special identification or help.

INSTITUTIONALLY CONTROLLED VARIABLES

- The admissions criteria and the availability and quality of supportive service programs have an important relationship to retention rates. Effective, comprehensive support programs should be developed on campuses that admit minority students whose academic preparation is weaker than that of the general student body.
- The retention rates of minority engineering students at predominantly white colleges has been found to improve when a "critical mass" of minority students is reached on each campus. The critical mass, in the meaning used here, is related to a minimum number of minority students in each class for intraclass peer support, as well as a minimum number of upperclass minority students, possibly by serving as role models, tutors, and counselors.
- Institutional commitment, as demonstrated by the faculty, is an important variable in the retention of minority engineering students. If the students perceive a sincere institutional commitment on the part of faculty and staff, their feelings of alienation are reduced, which contributes to an atmosphere conducive to success. Rigidity in course scheduling and course placement in the first year of an engineering program can contribute to attrition. Some students who have the ability to perform successfully in an engineering curriculum, but who have had weak preparatory academic experiences, may not be prepared to com-

plete a prescribed number and/or sequence of courses within the traditional time frame.

- Math and science courses taught by professors who present primarily theoretical concepts represent an added difficulty for many engineering students and can be even more of a problem for underprepared students. The problems result from the difficulty that engineering students encounter in their attempts to achieve the transition from theory to application and vice versa.
- Student jobs have mixed effects on student performance. For the underprepared student, jobs during the school term may have detrimental effects. For the better academically prepared students, jobs that require fewer than 15 to 20 hours per week generally have no adverse effects. Jobs that require more than that may adversely affect the academic performance of most students.

RECOMMENDATIONS

The Task Force recommends that all engineering colleges initiate procedures to monitor the progress and retention of minority students, as well as the entire student body, on an individual basis, with a view toward identifying the basic causes of attrition. The Task Force also calls on the Engineer's Council for Professional Development, through its existing data collection system, to begin collecting and compiling retention statistics from the engineering colleges in order to obtain national retention rates for all students and for minorities.

Based on the observations of the program directors, the Task Force further recommends:

- *Successful precollege academic programs need to be continued and expanded to increase the academic skills of the underprepared students who have a keen interest in engineering. To enhance their preparation in the appropriate subject areas, innovative programs should be developed that provide quality instruction. Such programs should use methods that enable minority students to bridge theory and application. The use of diagnostic testing and other methods for documenting progress, as measured by achievement, should be increased in precollege programs and the freshman year of engineering schools. Additionally, creative programs among colleges and high schools, aimed at upgrading the academic preparation of minority students, should be implemented.*
- *Engineering colleges should increase aggressive recruiting for well-*

qualified minority students and continue to develop academic support services for the students that require them.

- *Engineering schools should strive to create a positive and success-oriented learning environment for minority students (especially those who are admitted through special programs) by (1) not allowing underprepared students to cope alone with an overly demanding workload, (2) taking whatever steps are reasonable to assist minority students overcome academic difficulties, (3) admitting in each class of minority students a number of well-prepared students who can serve as success models for the remainder of the class, (4) expressing expectations for the success of the minority students as a group rather than expectations of failure, (5) offering enthusiastic support of minority students and minority programs rather than reluctant support, and (6) rewarding academic excellence among minority students.*
- *Engineering colleges need to develop comprehensive, coordinated support programs that begin ideally with contacts made among high school students and continue throughout the undergraduate years. Many colleges have support programs for freshman and sophomore students, but consideration should be given to modifying and extending those services to serve the needs of upperclass students. It is also recommended that the colleges continually conduct objective reviews of the effectiveness of support programs to supplement their subjective evaluation. The engineering colleges should provide counselors for addressing the personal and academic adjustment problems of minority students to supplement the academic counseling by the faculty advisors.*
- *Engineering schools should make greater use of flexible programs that facilitate the academic adjustment of the underprepared students. Examples include stretching some introductory courses over more than one term or semester, reducing course loads to allow more time for tutoring and skills development, course placement options, innovative use of summers and other vacation periods, and varied teaching techniques.*
- *Colleges and universities should provide counselors who are aware of the economic, educational, and social problems of minority students and well trained to aid such students in successfully dealing with them. Administrators and faculty members should clearly articulate their support for minority programs. Institutional policies regarding minority students should be announced and discussed in faculty and departmental meetings. The minority program should be an integral part of the college structure.*
- *Engineering colleges need to provide strong support and assistance*

to minority student engineering organizations in developing program planning, fund raising, and other necessary activities.

- *Engineering colleges should allocate sufficient funds to their minority programs for adequate staff counseling, planning, coordinating services, and other administrative duties. For this to occur, outside funding for college-level minority programs should be maintained or increased. It is also recommended that the state legislatures and other outside funding sources increase the resources given to the predominantly minority colleges to increase the number of permanent minority staff members.*
- *All engineering schools need to review their supportive services programs and modify them where necessary to ensure that the needs of the students who are admitted each year are met, particularly among underprepared students. Admissions officers should work closely with the minority program staff on a continuing basis to ensure that the services adequately meet the needs of the students.*
- *Minority program staff members who are not members of the faculty should interact as often as possible with members of the faculty, the dean's staff, and other university officials.*
- *Greater use of the college's regular faculty should be made in the academic components (summer program courses, tutoring sessions, etc.) of minority retention programs. Faculty members should interact as often as possible with minority students outside of the classroom to promote better communication. It is also recommended that engineering colleges use practicing professional minority engineers as adjunct professors to increase the number of minority faculty members when permanent minority faculty members are not available.*
- *School systems, engineering colleges, and other professional engineering societies and minority community organizations need to continue and expand their efforts to inform minority youth of the opportunities available in engineering careers. Ideally, such approaches should occur prior to the students' entry into high school, so that the students will be aware of the academic prerequisites necessary for entry into technical educational programs at the college level. However, engineering colleges should continue their career guidance and enrichment activities before and throughout the undergraduate program to improve student motivation and commitment to engineering.*
- *Engineering colleges, scholarship agencies, private corporations, foundations, and government agencies should continue to support financial aid programs at current or increased levels to minimize the impact of inadequate financial resources as a barrier to minority student retention. Financial aid packages for the less well-prepared students*

should not include a requirement for work-study jobs during the freshman year. If students must work, the jobs should be related to engineering. The college should strive to develop organized, comprehensive financial aid packages.

- *Engineering schools need to review their policies relating to required work-study jobs as a portion of financial aid packages and revise them where necessary to accommodate those students for whom working during the school year is detrimental to their academic success.*
- *Industry and government should increase the number of summer jobs and cooperative work-study programs for minority students as a means for increasing motivation and commitment to the engineering profession, to assist in the transition from theory to application, and to provide a source of income to support educational expenses. These should occur as early as possible in the academic career to help reduce early attrition.*
- *Engineering colleges should identify able minority juniors and seniors and/or graduate students to tutor other students. It is also recommended that the colleges inform students in need of tutoring that it is the student's responsibility to seek out and utilize the tutoring services available to them.*
- *Minority students attending predominantly white colleges need to be encouraged to become more involved in the mainstream of student life, through academic interaction outside of the classroom as well as extracurricular activities. However, minority students need to exercise caution in pursuing those activities that may be likely to limit or reduce academic achievement.*

AREAS OF FUTURE STUDY

Additional research is needed on the causes of attrition among minority engineering students and on the true retention rate of all engineering students by racial and ethnic designation. A national longitudinal study that follows students on an individual basis and seeks data directly from students would provide the most informative results. Research should be undertaken to verify the rank ordering of factors affecting retention, as reflected in this survey, in addition to determining the significance of the intervals between each factor. Other related areas in which research activities might produce useful results are the relationship between retention and quality of instruction, grading standards, academic success, and career mobility. Objective analyses are necessary at long last to supplement subjective evaluations of the effectiveness of prefreshman summer programs and other minority program components.

Introduction

Blacks, Mexican-Americans, Puerto Ricans, and Native Americans together constitute just over 13 percent of the total U.S. population, but account for only 2 percent of the nation's 1,072,000 practicing engineers. By any standard, this is a serious underrepresentation. Such a disparity is an important issue for minority groups, engineering educators, professional engineers, and, indeed, the entire nation. The immense scientific and technological challenges confronting this country can best be met if all technically talented individuals have an opportunity to contribute to their solution. The engineering profession has responded by adopting a goal of significantly increased minority participation in engineering by the mid-1980's.

Since 1972, strides have been made in increasing the enrollments of minorities in engineering schools (see Figure 1). Such growth is a result of extensive recruiting by many engineering schools. However, graduation rates (see Figure 2) are not increasing at the same pace as enrollments. Reducing the attrition rate for minority students will contribute to more rapid progress in achieving the goal of increased participation, as well as diminish the number of students who experience the damaging personal effects of having failed in their chosen field of study.

BACKGROUND

The historically black engineering colleges provided the major source of black engineers until the late 1960's, when the engineering profession recognized the need for greater numbers of minority engineering students. At that time, several of the traditionally white engineering colleges implemented programs designed to attract minority students. *Minorities*

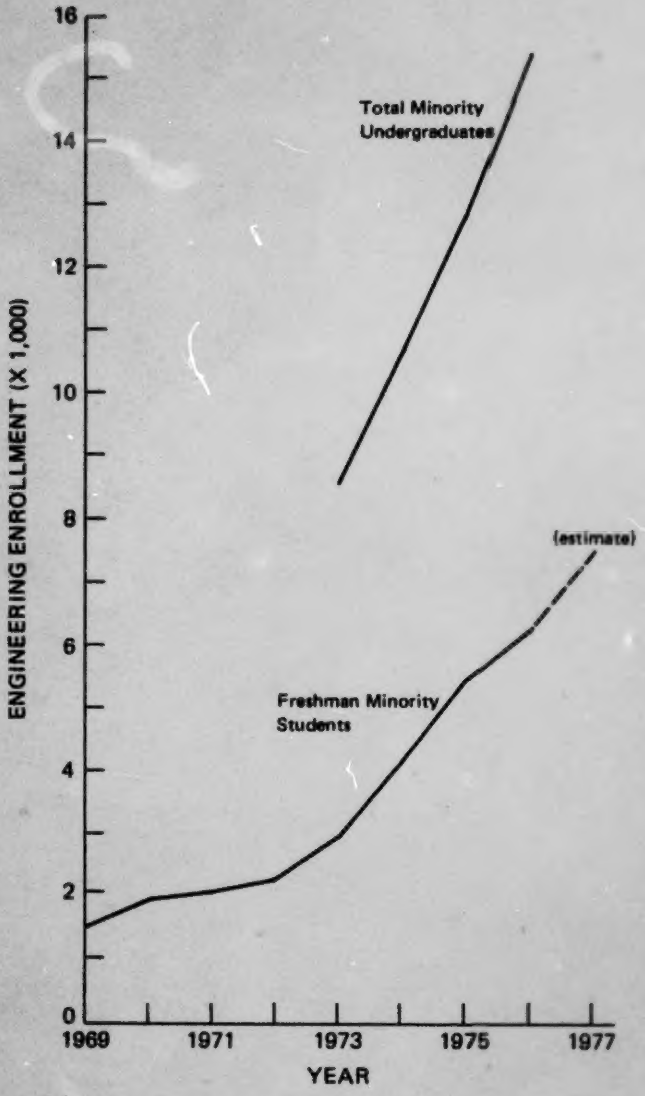
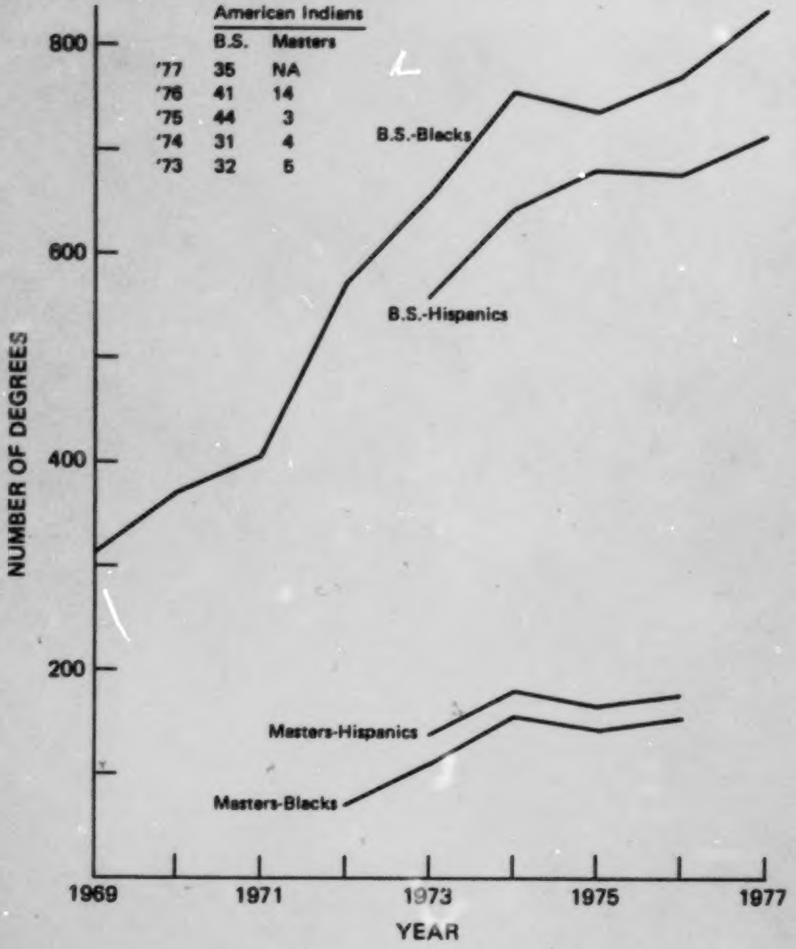


FIGURE 1 Enrollments of underrepresented minority students in engineering, 1969-1977.

SOURCE: Engineering Manpower Commission, Engineers Joint Council.



American Indians

	B.S.	Masters
'77	35	NA
'76	41	14
'75	44	3
'74	31	4
'73	32	5

FIGURE 2 Bachelors and masters engineering degrees earned by under-represented minorities, 1969-1977.

SOURCE: Engineering Manpower Commission, Engineers Joint Council.

in Engineering—A Blueprint for Action reported that from 1969 through 1973 almost 66 percent of all engineering bachelor's degrees earned by blacks were awarded by just 25 engineering colleges, with the six predominantly black schools accounting for 47 percent of the total number. By the early 1970's many of the traditionally white engineering colleges made special efforts to include the underrepresented minorities in their entering classes.

The growing national interest in minority student participation in engineering education prompted the development of national and regional organizations to assist in the coordination of college and industrial programs at the local level. In December 1972, the Minority Engineering Education Effort (ME^3) Task Force was organized by the Engineer's Council for Professional Development (ECPD) to identify and motivate minority high school students with an interest in engineering. In May 1973, the goal of a tenfold increase in minority engineering graduates (from 500 to 5,000) was formulated during the Symposium on Increasing Minority Participation in Engineering, sponsored by the National Academy of Engineering. In February 1974, the Academy organized the National Advisory Council on Minorities in Engineering (NACME) to help activate the resources needed to achieve the goal. In April 1974, the Academy formed the Committee on Minorities in Engineering to encourage and stimulate activities at the national and local levels that could contribute to increases in the number of minority engineering graduates and to serve as a clearinghouse for information to relevant groups and organizations participating in the effort.

Two other significant events occurred in 1974. *A Blueprint for Action,* a report by the Planning Commission for Expanding Minority Opportunities in Engineering, supported by the Alfred P. Sloan Foundation, offered guidelines and recommendations for increasing opportunities in engineering education for underrepresented minorities. The other major development was the organization of the Minority Introduction to Engineering (MITE) Program by ECPD. MITE programs are one or two-week summer programs conducted by engineering colleges for minority youth who have completed the junior year of high school.

Other organizations are expected to have an important impact on the production of minority engineering graduates. The National Fund for Minority Engineering Students was established in 1975 to help increase the supply of minority engineers. The Fund has been recognized as the national organization designated to raise and distribute the extensive financial resources needed to improve access to engineering for minority students. In 1976, the National Coordination Center for Curriculum Development was established to promote a better understanding by teachers, minority students, and parents of the nature of modern engineering work and to improve the required skills of college-bound minority students who want to pursue technical studies. In addition, the National Consortium for Graduate Degrees for Minorities in Engineering has as its main objective the increase in the number of minority men and women with graduate degrees in engineering.

Regional organizations and consortia also have initiated programs to increase the number of minority engineers. Examples include the Committee to Increase Minority Professionals in Engineering, Architecture and Technology (CIMPEAT) of Atlanta, Philadelphia Regional Introduction for Minorities to Engineering (PRIME), California Consortium for Minorities in Engineering, Committee for Institutional Cooperation + Midwest Program for Minorities in Engineering, Inroads, Inc., Engineering Colleges Consortium for Minorities, Texas Alliance for Minorities in Engineering (TAME), and Southeast Consortium for Minorities in Engineering. Such organizations are in various stages of development. All are working within their own communities or regions to increase the pool of prepared and motivated minority students for engineering schools and to enhance the support activities for minority students in undergraduate engineering programs.

RELATED RESEARCH

The American Society for Engineering Education (ASEE) undertook a series of studies in 1974 and 1975 on the retention of all students in engineering under the direction of R. Foster. The initial study was on students who entered college in 1966, and the most recent was for students who entered in 1973. Such studies did not identify students by racial and ethnic group, so that no specific analysis of minority students could be made. However, the ASEE studies present findings on the retention of engineering students in general. These are summarized as follows: (1) students who start in engineering persist as well as all students in general; (2) most engineering students who transfer out of engineering remain in some program in higher education; (3) more students starting in engineering return for a second year in some programs than all students in general; (4) high school grades and Scholastic Aptitude Test (SAT) scores seem approximately equal as predictors of student performance in higher education; (5) among freshmen in engineering, the ability to enter the second year is strongly dependent on high school grades if SAT scores are low, but ability to graduate in four years is dependent on high school grades when SAT's are high; (6) those remaining in engineering found math and physics more interesting than those who left; (7) financial resources make a significant difference for those remaining in engineering and those who left; (8) students who leave engineering studies appear to have a sense of alienation, inadequacy, and lack of motivation; (9) those who remain in engineering schools tend to have a solid academic background and to be vocationally oriented; and (10) students who remain in engineering schools are likely to have made an early commitment to an engineering career, received moral encouragement from their parents and friends, and exhibited a willingness to exert the effort needed to graduate.

Purdue University has conducted a study to determine the factors associated with attracting and retaining black Americans in engineering on its campus over a 10-year period ending in 1974. The results and conclusions of that study indicate that: (1) retention rates of black freshmen in engineering are similar to graduation rates in engineering, but tend to be somewhat lower than graduation rates for nonblack engineering students; (2) black students took longer to graduate and experienced greater academic difficulties during their sophomore year than nonblack engineering students; (3) the best predictor of retention in engineering is grades during the freshman year for blacks as well as nonblacks; traditional admissions criteria, such as College Board scores and high school rank, are at best low predictors of academic grades and persistence in engineering for blacks; (4) black students in engineering tend to even a greater extent than nonblack students to be more committed, independent, and achievement-oriented than those who transferred to other programs or withdrew from college; (5) special tutorial programs are useful to black freshmen, and when such programs were no longer available, students had greater difficulty in adapting to the academic demands of the engineering program; (6) recent black B.S. engineering graduates continue to achieve and aspire to achieve advanced and professional degrees in engineering (Bond, LeBold, Thomas, 1977).

In his recent analysis of data on black freshmen in 1968 in two-year colleges and four-year colleges who expressed an interest in engineering, Kaufman (1977) draws some interesting conclusions. While his sample was small, he finds that financial aid, motivation, and academic preparation are important variables in the retention equation. Such conclusions parallel those of our study. However, Kaufman's implication that special efforts and/or programs to increase retention have not been effective does not agree with our study; nor does it seem appropriate that he included in his retention rate calculations students who *intended* (many at two-year colleges) to major in engineering, rather than those who had actually registered in engineering. It is important to note that the students in Kaufman's analysis were enrolled in engineering schools before most of the retention programs described in this report were implemented.

In a June 1975 report for the U.S. Office of Education on the impact of special services programs in higher education for disadvantaged students, the Educational Testing Service indicates the value of supportive service programs for students who have had weak academic preparation in high schools. Among the conclusions of this report are that: (1) the most reliable indicator of later academic success is previous academic performance; (2) institutional differences (cost, grading standards, attrition rates, the nature and social patterns of student bodies, features attractive to students), account more for differences in the success and satisfaction of disadvantaged students than do the presence or absence of particular support services; and (3) the maintenance of smoothly functioning programs on campuses requires an honest and demonstrable institutional commitment, a respected and capable program director, the concern and involvement of the regular teaching faculty, and a critical mass of minority students.

The Retention Problem

RETENTION RATES

In an effort to obtain reliable national data on retention rates for minority students and all students in engineering education, the Retention Task Force mailed two survey instruments (see Appendixes) to engineering colleges.

The first questionnaire was sent to 200 schools. Only 30 responses were received. The second questionnaire was sent to 71 of the originally surveyed schools having over 80 percent of the total number of enrolled minority engineering students for that year. In all, 34 responses were received. The schools from which responses were obtained have 40 percent of all minority students enrolled in engineering programs.

Table 1 lists the retention rates based on the Task Force survey. The minority students in this sample who matriculated as freshmen in 1973 represent 25 percent of the total minority freshmen engineering enrollment of 2,987 students, as reported by the Engineering Manpower Commission (EMC), and the students in the all-student freshman enrollment in our data base for that year represent 14 percent of the 51,920 total freshman enrollment, as reported by EMC. The minority students in the sample who matriculated as freshmen in 1974 represent 18 percent of the 4,018 total minority freshman enrollment, as reported by EMC.

The data show that for the students who matriculated at the 30 colleges in 1970, 43 percent of the minority students and 55 percent of all students had either received engineering degrees or were still enrolled in the fall of 1975. For those students who matriculated in 1971, some 40 percent of the minority students and 56 percent of all the students had received degrees or were still enrolled in the fall of 1975.

TABLE 1 Retention of Engineering Students

For this summary, retention is defined as having been enrolled in the fall of 1975, or having received an engineering degree in that year. Of the 25 colleges included in the one-year, all-student sample, 7 reported freshman classes of less than 200 students; 14 reported freshman classes of between 200 and 400; 2 reported freshman classes of between 400 and 600; and 2 reported freshman classes of over 600 students.

	Minority Students			All Students		
	Number Entered	Number Retained	Retention Rate (%)	Number Entered	Number Retained	Retention Rate (%)
5 yr Retention (Enrolled or Graduated)[a]	445	193	43.3	6,653	3,688	55.4
4 yr Retention (Enrolled or Graduated)[b]	565	224	39.6	6,644	3,700	55.7
3 yr Retention (Enrolled)[c]	539	239	44.3	6,293	4,101	65.2
2 yr Retention (Enrolled)[d]	760	388	51.0	7,322	4,911	67.1
1 yr Retention (Enrolled)[e]	723	529	73.2	7,709	6,074	78.8

Data Sample for Minority Students:

[a] from 23 colleges and from 20 colleges for all students for class that matriculated in 1970.
[b] from 24 colleges and from 22 colleges for all students for class that matriculated in 1971.
[c] from 28 colleges and from 25 colleges for all students for class that matriculated in 1972.
[d] from 30 colleges and from 26 colleges for all students for class that matriculated in 1973.
[e] from 29 colleges and from 25 colleges for all students that matriculated in 1974.

00 30

The remaining data collected showed that 44 percent of minority students and 65 percent of all students who matriculated in 1972 were still enrolled; 51 percent and 67 percent, respectively, of minority students and all students who entered in 1973 were still enrolled; and 73 percent of minority students compared with 79 percent of all students were still enrolled after one year.

Only 12 of the colleges provided complete retention data with which year-to-year retention rates could be calculated and compared. The minority students at these institutions represented 20 percent of the total minority engineering students enrolled in the academic year 1976-77. The rates calculated are shown in Table 2. Such data suggest that retention rates are improving. The Task Force believes that the increased availability of support programs for all students, the better background of enrolling students, improved instruction, higher grade point averages resulting from many factors, and other developments on the campuses have all contributed to better retention rates for all engineering students. It is interesting to note that the improvement in the retention rate for minority students is greater than that for all students.

Because special support programs, with differing program components, have been instituted for minorities in these institutions, it is reasonable to conclude that such programs have had some affect on the retention of minorities. Additional studies recommended in this report in the section entitled "Areas for Future Study and Investigation," will need to be made to determine the more precise correlates between retention program components and retention rates.

From Table 2 a projection can be made for future year-to-year retention rates. For instance, the average year-to-year retention rates for minorities for this group of 12 institutions, have been increasing steadily

TABLE 2 Average Year-to-Year Retention Rates, 1970-1974

Year	Average Year-to-Year Retention Rate—All Students (%)	Average Year-to-Year Retention Rate—Minority Students (%)
1970	50.0	44.3
1971	51.4	45.0
1972	60.5	48.6
1973	64.4	55.3
1974	77.3	78.2

since 1970. The increase for minority students has been 33.8 percent, with a concomitant increase for all students of 26.3 percent. Such figures suggest that on the average minority engineering students for a group of 12 institutions have experienced a greater growth in year-to-year retention rates than for all students.

Other conclusions can be drawn from the retention data that probably hold true for most minority engineering students. Minority students currently experience a lower retention rate than all students combined. Minority students retention rates are improving, however, based on the projections for the schools in this data base. The difference in graduation retention rate for minority and all students is about 12 percent. The greater differences between retention rates for the five-year and four-year rates indicate that minority students on the average require more time to complete degree programs than do all students. This is confirmed by the response to our second survey instrument, which showed that the average length of time to graduate for all students was 9.95 terms and for minority students 10.5 terms. The difference in year-to-year retention rates for minority students, in contrast to all students for the class that entered in 1974, is considered to be due to the increased effectiveness of the supportive service programs on the campuses and/or other institutional policies applied to students in special programs.

Table 3 shows that the minority retention rates at the private colleges

TABLE 3 Retention of Minority Engineering Students in Public and Private Schools

All statistics refer to students who were either attending engineering school in the fall of 1975 or had received an engineering degree that year.

	Public Colleges			Private Colleges		
	Number Entered	Number Retained	Retention Rate (%)	Number Entered	Number Retained	Retention Rate (%)
5 yr Retention [a]	204	84	41.2	241	109	45.2
4 yr Retention [b]	231	91	39.4	334	133	39.8
3 yr Retention [c]	276	120	43.5	263	119	45.2
2 yr Retention [d]	407	199	48.9	353	189	53.5
1 yr Retention [e]	368	262	71.2	355	267	75.2

[a] Data from 8 public and 15 private colleges for the class that matriculated in 1970.
[b] Data from 9 public and 15 private colleges for the class that matriculated in 1971.
[c] Data from 13 public and 15 private colleges for the class that matriculated in 1972.
[d] Data from 14 public and 16 private colleges for the class that matriculated in 1973.
[e] Data from 13 public and 16 private colleges for the class that matriculated in 1974.

are higher than those at the public colleges. This is probably the result of more selective admissions policies and better financial aid policies at the private colleges.

The preceding analysis indicates that there is indeed a difference in the retention rates of minority students and all engineering students at those schools that provided data. The fact that this disparity exists on a nationwide basis can be supported by examining a graduation rate based upon the comparison of full-time freshman enrollments in the fall of 1973 (accurate minority enrollment figures before 1973 are not available) with the number of B.S. engineering graduates in 1977.

Graduation rates are one measure of retention, but do not represent true retention rates because some students transfer into programs, some "stop out" (leave the program voluntarily but return to complete the engineering degree program), some are temporarily suspended from school but return to complete the degree program, and others stretch out their educational programs by taking reduced course loads, participating in cooperative education programs, or by attending school on a part-time basis. The Engineering Manpower Commission (letter dated September 21, 1977, from John Alden) estimates that a total of 1,580 minority students received B.S. engineering degrees in June 1977 and reported that there were 2,905 minority, full-time freshmen in 1973. EMC reckons that the total number of students receiving B.S. engineering degrees in 1977 was 40,340 and that the total number of full-time freshman students in 1973 was 51,920. The graduation rate indicated by these national data is 54.5 percent for minority students and 77.8 percent for all students—a difference of 23.3 percent.

FACTORS THAT IMPACT UPON RETENTION

The second Task Force instrument sought the opinions of the college representatives who work directly with minority students on the relative impact of 20 factors on the persistence of minority students. Table 4 lists their combined, rank-ordered responses. The differences in the relative importance of these items at the traditionally white public and private colleges and the historically black colleges are shown in Table 5. These results were obtained by separating the survey responses into the three categories and averaging for each group. Additional research to confirm these findings can be accomplished by securing the cooperation of a larger number of colleges in participating in the study and by obtaining data directly from students.

TABLE 4 Significant Retention Factors Rank Ordered by 31 Engineering Colleges

---

Motivation Toward Engineering
Math Preparation Prior to Matriculation
Academic Performance
Availability of Adequate Financial Resources/Aid
Self-Confidence of Students to do the Work
Availability and Quality of Counseling
Availability and Quality of Tutoring
Personal/Family Problems
Admissions Criteria
Existence of Minority Student Organizations
Rigidity/Flexibility of Curriculum
Faculty Attitude Toward Minority Students
Availability of Summer/Permanent Jobs in Engineering
Social/Economic Background of Students
Attitude of Minority Students Toward Majority Faculty/Students
Existence of Minority Faculty Members
Change in Career Goals
School Setting (Rural vs. Urban)
Attitude of Majority Students Toward Minority Students

Motivation

Based on the observations of the minority program directors, lack of strong motivation toward engineering is one of the leading causes of attrition for minority engineering students. Conversely, motivation toward the study of engineering is the most salient personal characteristic of minority students who remain in engineering. This finding is consistent with the results of other studies of engineering students, which have shown that motivation toward a particular career is an important characteristic among those who complete a degree program.

Lack of motivation for most of the students should be interpreted as a weak vocational interest rather than a weak motivation for academic achievement. The program directors reported that minority and majority students who drop out or leave engineering programs generally have a very high completion rate for other academic programs.

The factors that can influence motivation before matriculation into an engineering curriculum are many and somewhat diverse. For instance, knowledge about the different fields of engineering, particular job functions, and the career aspirations of most engineers, can help prepare and motivate the student. Minority students have not traditionally received this type of counseling.

TABLE 5 Rank Order Listing of Factors That Impact Upon Minority Student Retention

Public Schools * (19)	Private Schools * (9)	Black Schools (3)
Motivation for Engineering	Math Preparation	Math Preparation
Math Preparation	Counseling	Motivation for Engineering
Science Preparation	Admissions Criteria	Availability of Financial Aid
Academic Performance	Motivation for Engineering	Academic Performance
Availability of Financial Aid	Tutoring	Science Preparation
Self Confidence	Science Preparation	Counseling
Personal/Family Problems	Student & Organizations	Tutoring
Tutoring	Academic Performance	Rigidity/Flexibility of Curriculum
Admissions Criteria	Self Confidence	Student Organizations
Social/Economic Background	Personal/Family Problems	Existence of Minority Faculty
Counseling	Availability of Financial Aid	Self Confidence
Student Organization	Faculty Attitude	Personal/Family Problems
Rigidity/Flexibility of Curriculum	Availability of Jobs	Availability of Jobs
Faculty Attitude	Rigidity/Flexibility of Curriculum	Social/Economic Background
Minority Student Attitude	Change in Career Goals	Faculty Attitude
Availability of Jobs	School Setting	Change in Career Goals
Existence of Minority Faculty	Existence of Minority Faculty	Admissions Criteria
Change in Career Goals	Majority Student Attitude	School Setting
School Setting	Social/Economic Background	
Majority Student Attitude	Minority Student Attitude	

* Excluding predominantly black schools.

Along with an understanding of the role of an engineer, a student should be aware of the self-discipline usually required to be successful in an engineering curriculum. A student will be better prepared to undergo the rigors of an engineering curriculum if he or she knows the math and science course work requirements of the freshman and sophomore years. The student must be motivated to meet the curriculum demands, as well as be committed to an engineering career. Motivated students tend to be those who are academically prepared and who understand the demands of an engineering education and the career possibilities which that education provides.

Academic Preparation

Insufficient math and science preparation prior to entering engineering programs is the second most important controlling factor in the persistence of minority engineering students. Insufficient preparation, to a large extent, results in poor academic performance after the students have enrolled in an engineering program. Because of the nature of the engineering curriculum, the better an individual's command of and facility with high school level mathematics and physics, the more academically capable he will be in an engineering program. The quality of the high school experience in these subjects is directly related to the ease with which an individual enters into an engineering program.

It has been reported by Coleman and others that the quality of the education received by many minorities in the nation's elementary and secondary school systems is inferior to that of the majority population because of segregated schools, unequal funding allocations, etc. Those minority students who have attended such schools are especially disadvantaged when they undertake engineering or other technically oriented courses of study at the college level. Inadequate math and science preparation increases the likelihood of academic problems and higher attrition rates in an engineering program.

The unequal status in math and science preparation for minority students compared to majority students can be readily discerned by referring to Table 6, which reports student declarations of need for remedial work. The data are from a survey conducted by the Cooperative Institutional Research Program of the American Council on Education and the University of California at Los Angeles of students who entered engineering programs in 1976 and included 22,353 white students, 1,470 black students, 112 American Indian students, 243 Chicano students, and 145 Puerto Rican students. The data show that 34.5 per-

TABLE 6 1976 Freshman Engineering Student Declaration of Need for Remedial Work

	English (%)	Reading (%)	Math (%)	Science (%)
White	11.6	6.1	10.8	5.8
Black	22.5	15.6	34.5	22.9
American Indian	18.8	7.1	16.1	8.0
Chicano	25.9	12.3	24.3	20.6
Puerto Rican	28.3	1.6	29.7	15.2

SOURCE: Cooperative Institutional Research Program of the American Council on Education and the University of California at Los Angeles.

cent of the black students, 16.1 percent of the Indian students, 24.3 percent of the Mexican American students, 29.7 percent of the Puerto Rican students felt the need for remedial work in math, while only 10.8 percent of the white students felt a need for remedial math work. A similar situation is apparent with respect to science. Nearly 6 percent of the majority students felt the need for remedial work in science, as compared to 23 percent of the black, 8 percent of the American Indian, 21 percent of the Mexican American, and 15 percent of the Puerto Rican students. The largest differentials occur in mathematics preparation, which is the subject area most critical to engineering curricula. Such obvious differences in preparation in these vital subject areas, leads one to expect higher attrition rates for minority students than for majority students.

In addition to science and math preparation, there are other factors that can influence a student's academic performance. If students cannot make the appropriate academic adjustments to compensate for deficiencies in reading and study skills, test taking ability, ability to compete with equally or better prepared students, mental discipline, etc., attrition will occur disproportionately to the students' intellectual capabilities. Tinto and Sherman (1974) report that:

> The inability of persons to complete a given educational program has been shown to be the product of many factors largely independent of the individual's ability. Beyond the characteristics of family and community environments, the quality of one's schooling has been thought to play an especially important role in the process of educational attainment. For persons from lower status backgrounds in particular, inferior quality of teaching staffs, limitations of educational resources, and insufficient counseling among other items have been seen as largely reinforcing the paucity of educational stimuli in their out-of-school environments.

Academic Performance

Poor academic performance is a major contributor to the attrition of minority students in engineering. For the schools that responded to our survey instrument, the percentage of minority students who were on academic probation or warning was about twice that of all the students at those schools for the 1975-76 school year.

Even though the minority students generally were less prepared in math and science, Table 7 indicates that their overall achievement in high school was somewhat comparable to the nonminority students who entered in the fall of 1976. Sixty-seven percent of the white students earned average high school grades of B+ or better, compared with 46 percent, 65 percent, and 60 percent, respectively, for the black, American Indian, Mexican-American, and Puerto Rican students.

Our survey shows that 10.4 percent of minority students and 7.5 percent of all students left college temporarily because of academic suspension or probation. Of those who left for this reason, 41 percent of the minority students and 23 percent of all students returned to school following the suspension, some in engineering and others in other programs. The success rate for those who return to engineering varies from school to school.

Financial Aid

The most critical consequence of insufficient financial resources is that a student must withdraw from the program because of his inability to pay tuition and other educational expenses. Students who lack the proper funds can also spend excessive amounts of time worrying about

TABLE 7 Average High School Grades of 1976 Entering Engineering Students

	A or A+ (%)	A− (%)	B+ (%)	B (%)	B− (%)	C+ (%)	C (%)	D (%)
White	20.9	21.2	24.8	18.7	7.5	4.6	2.1	0.1
Black	10.4	12.2	23.2	24.5	11.2	11.1	6.8	0.6
American Indian	20.5	20.5	24.1	14.3	11.6	3.6	5.4	0.0
Chicano	18.3	20.7	20.3	19.9	11.6	6.2	2.9	0.0
Puerto Rican	11.9	17.5	30.8	21.0	11.9	4.9	2.1	0.0

SOURCE: Cooperative Institutional Research Program of the American Council on Education and the University of California at Los Angeles.

their financial status or in the financial aid office of the institution seeking additional aid. When this occurs with great frequency it can interfere with the time available for academic pursuits, so that the students' academic performance ultimately suffers. This observation by some of the campus representatives is supported by the analysis of American Council on Education data by Alan E. Bayer in *The Black College Freshman: Characteristics and Recent Trends.* Bayer has reported:

> As in 1968, far more non-blacks depended on their families to provide financial support for their college education. Blacks, in contrast, were twice as likely (40%) as were non-blacks (18%) to depend on scholarships and grants as a major source of financial support. Given these differentials in financial resources, in combination with differentials in family economic status, it is not surprising that blacks expressed substantially more anxiety about their ability to finance their college education. In 1968, one fifth (21%) of the blacks and one twelfth (8%) of the non-blacks said they had major concern about finances. In 1971, the comparable figures were 25% and 10%, respectively.

Students who work more than 10 to 15 hours a week while in school also have less time and energy to devote to their academic work. Astin (1972) reported that for all students pursuing higher education, students that are employed during the school year have less chance of remaining in college. The urban engineering colleges reported that many students who attend their colleges on a part-time (and sometimes full-time) basis have full-time jobs and carry a heavy academic load of evening classes. Under these circumstances, the students may be too physically and emotionally exhausted to perform up to their academic abilities.

Many minority students just entering college tend to be less aware of university and college deadlines for financial aid applications. Because of this, many minority students who qualify are not likely to receive aid because forms are not completed correctly or returned on time. Most minority students in engineering who qualify for financial aid do receive some form of financial aid. However, the instruction of new and prospective students about available financial aid and application deadlines can reduce the effects of this problem.

The availability of adequate financial aid was ranked as a more important retention factor by the predominantly black colleges than the predominantly white public or private colleges. The black colleges have long suffered from limited institutional resources, and this in turn limits the amount of money available for providing scholarships to their students. Most of the educationally disadvantaged students who attend the predominantly black colleges are also economically disadvantaged. This places an additional burden on these colleges. The predominantly white public colleges also suffer from an inability to provide all the financial support that their minority students need. The private colleges, however, generally have sufficient institutional funds to provide the supplemental aid that their minority students require. Several of the private colleges have a policy of guaranteeing financial aid to minority students to equal their calculated need.

In response to the survey instrument, five of the public schools estimated that on the average 10 percent of their minority students in good academic standing left school because of inadequate financial aid (1974-76), while seven of the schools reported that none of their students in good standing left for financial reasons. Eight of the private colleges reported that no minority students in good standing left school because of insufficient financial resources, while one private college estimated that approximately 4 percent left for that reason. One of the predominantly black colleges estimated that 1 percent left and another estimated that 5 percent left who were in good standing but lacked the money to remain.

Self-Confidence

Lack of self-confidence in their ability to compete with their classmates and to progress through the engineering program causes many minority students to give up and drop out of engineering before they have allowed themselves adequate time to accurately judge their capabilities for completing the program. The minority program representatives reported that confident students are less tentative in attacking personal and academic problems, are more aggressive about promoting their self-interests, less reluctant to seek help, and more readily involved in the mainstream of student life. Successful experiences help to build self-confidence and repeated unsuccessful experiences tend to diminish one's self-confidence. Those minority students who earn poor grades throughout the first semester and first year in the engineering program, because of their relatively disadvantaged educational position compared to their peers, begin to doubt their ability to compete. This frame of mind can be damaging because individuals tend to perform according to their expectations. When minority students adopt an attitude of inferiority, they may begin to perform in an inferior manner. Academic preparedness and self-confidence thus go hand in hand. Continued absence of positive reinforcement (i.e., good grades) and loss of confidence in one's ability to master course work can lead to a reduced interest in pursuing an engineering degree and subsequent attrition from the engineering program.

Additional Factors

Minority students encounter many of the same personal and academic problems that majority students face, but the problems are often more severe and some are of a different nature according to the observations of the program directors. Counseling services that can adequately serve the needs of the students can impact positively upon the chances of retention for minority students. Because many of the problems faced by these students are different from those of their white peers, the normal counseling services at the predominantly white colleges and universities need to be strengthened to ensure that the full range of appropriate advice is available for those students.

Effective counseling appears to be a more critical factor at the predominantly white private colleges than at the predominantly white public colleges or the black colleges. This may be because the minority students are more dissimilar to their classmates at the private colleges than at the other two categories of institutions. The intensity of academic competition may be greater at the private schools, and the emotional and social adjustment may be more difficult at these institutions. The absence of counseling that can effectively counteract the feelings of alienation that result from those differences will contribute to higher minority attrition rates.

Tutoring can compensate to some extent for inadequacies in the high school educational experience. Many of the engineering schools have found that effective tutoring improves the retention of their minority students. Without it, many students with the ability to successfully complete an engineering program, but who have had insufficient training in the prerequisite courses, drop out or are not successful at the college level.

Many minority and majority students encounter personal problems that can be disruptive to their progress through the engineering curriculum. If there is any difference in the character of the problems of the minority and majority students, it is probably that the minority students have more severe family problems. Many of the minority students are members of low-income, urban families. Because of their economic situation, the parents or siblings are more apt to encounter crises than the families of most majority students. Even if the minority students live away from home, the family problems can affect their ability to remain in school. The minority program staff members and college counselors cite this problem as a very serious one that interferes with minority students' academic performance.

The selection criteria for admissions can have a major impact upon the retention rate at a particular school. Schools with open admissions policies would be expected to have lower retention rates than very selective schools. Students with the best academic preparation would be expected to have the best retention rates all else being equal. Normally the colleges with open admissions policies provide the preparatory and compensatory courses that the students may need, in addition to broad-based supportive services, so that capable students do have a reasonable chance of successfully completing the program. It is reasonable to expect that some who enter open admissions engineering colleges simply do not have the academic skills to handle engineering and will figure in the mortality rate. A major cause of attrition for minority students has been that some minority students were admitted to particular schools where they had little chance of succeeding, either because of the lack of effective supportive services at the colleges or the totally inadequate academic backgrounds of the students.

Admissions criteria impact upon the retention of minority students at the private colleges to a greater extent than the other schools according to the responses to the survey instrument. The private colleges are generally very selective in their admissions process so that most of their students have good academic credentials. The minority students who are admitted to these schools must also be highly qualified to stand any reasonable chance of surviving in the program. If the breadth and depth of the academic preparation of the minority students is significantly inferior to that of their majority classmates at the point of entry into the program, many of the minority students are probably doomed to failure before they begin.

Minority engineering student organizations can have a positive impact upon the retention of minority students at the predominantly white colleges because the organizations often provide a mechanism for social and academic peer support.

A negative attitude by majority faculty members toward minority students can be especially detrimental to the students' self-confidence and motivation for remaining in school. If particular faculty members are insensitive to the special needs of the minority students, or if they appear to be condescending or bigoted, the students may feel that their work will be judged in a biased manner and will be less motivated to perform to their maximum ability.

The availability of career-related summer jobs can have a positive impact upon the retention of students. When the summer and co-op jobs are in the engineering and technical fields, there is an incentive to enter and remain in those curricula.

Rigid course schedules can lead to increased attrition and flexible course schedules may contribute to increased retention rates. If minority students take reduced course loads or otherwise get out of step in a rigid curriculum structure, the opportunity to take required courses in itself becomes a problem.

The social and economic background of the students, if very different from that of the majority students, can be a significant attrition factor. When minority student enrollments are a very small percentage of the total enrollments, the students may feel alienated and isolated and therefore may not be in the most favorable frame of mind for working to their full potential. Foster reported that, for engineering students in general, those who leave engineering appear to have a sense of alienation.

The attitude of the minority students toward majority students and faculty, if negative and belligerent, can contribute to increased attrition among the minority students. Such feelings, if extreme, are nonproductive and energy-consuming and can detract from the students' ability to concentrate on academic endeavors. Foster's research again shows that, for all engineering students, persisters view their academic environment in a more positive manner than nonpersisters.

The existence of minority faculty members within the college can have a positive impact upon the retention of minority students. Not only does their presence reduce feelings of alienation among the students in part by serving as role models, but it also serves as a signal that the administration has a true interest and commitment to minority student participation in engineering education.

Changing one's career goals is a cause of attrition for both minority and majority students, but it is probably a more important causative factor for majority students than minority students of equal academic preparation and ability.

The location of the school is another factor. If the school is located in a large urban setting and close to a student's home, it may be easy for the student encountering problems and disappointments to give up and drop out of the program. Also, the temptation to fall back into social groups off campus can be a detriment to good study habits.

For those students who commute to school and live at home, the home environments are not always conducive to effective studying. Commuting students also do not receive the benefits (such as peer support) that can be obtained by being immersed in an academic atmosphere outside of the classroom. Minority students from large urban centers who attend rural, predominantly white institutions may find it difficult to adjust to the different life-style and surroundings. The difficulty of the adjustment may cause them to drop out and go home.

If the attitude of the majority students toward the minority students is hostile in nature the result can be damaging to the emotional and psychological health of the minority students. At a national seminar on student retention for all higher educational programs, which was sponsored by the National Association of College Admissions Counselors and the American College Testing Program in February 1976, it was reported that a "staying environment" on a campus was one in which students had a feeling of belonging, personal worth, positive identity, and high self-esteem.

Other factors contributing to the attrition of minority engineering students include improper matches between students and schools (the student simply does not like the school because of the weather or the grading system or some other personal preference), or sometimes the students have the interest but not the aptitude for engineering.

Retention Program Components

The previous chapter briefly outlined and discussed the major causes of attrition and their relative importance. This chapter will discuss the various methods that engineering colleges have employed to successfully address those causes of attrition. These program components are discussed separately to simplify their presentation, but a program is successful only when the services provided work together in an integrated and comprehensive manner. Table 8 lists the programmatic methods that the colleges have reported for effectively reducing attrition.

PRECOLLEGE PROGRAMS

Prefreshman Summer Programs

Twenty-one of the 34 colleges that responded to the survey instrument conducted prefreshman summer programs in 1975 for minority students that would matriculate as freshmen in that same year. Two of the remaining colleges reported plans for programs for the summer of 1976. Thirteen of the programs were four weeks or longer in duration and academic course work and skill building were the major components. Some of the remaining programs contained academic components, but most of the activities were motivational in nature and were designed to provide orientation to the campus and campus life, orientation to engineering, and skill building. The major program components are summarized in Table 9.

The portions of the programs that were reported most often for having the greatest impact on the retention of the student participants were

TABLE 8 Retention Program Components

Tutoring Supplemental to that Normally Provided
Advising Supplemental to that Normally Provided
Minority Engineering Student Organization
Career Guidance
Work Experiences—Co-op/Summer
Pre-College Summer Programs—Orientation/Academic/Motivational
Faculty Involvement in Program
Administrative Staff Positions for Program
Commitment of Administration/Faculty to Program
Adequate Financial Aid/Scholarships
Merit Awards
Recognition Banquets and Awards
Reduced Course Loads When Appropriate
Academic Year Programs for High School Students
Diagnostic Testing/Effective Placement Procedures
Flexible First Year Curriculum
Effective Recruiting/Admissions Policies to Increase Overall Minority Enrollment
Minority Professional Engineers as Role Models
Extensive Personal Contact with Students by Faculty and Program Staff

calculus and math courses, chemistry courses, campus orientation activities, engineering orientation activities, study skills building exercises and counseling, and tutoring provided by minority engineering students. Physics courses, English and communications-building courses, visits by industrial representatives, and diagnostic tests were mentioned less often for having a great impact on reducing attrition.

Other Programs

There are other kinds of precollege programs that differ from the prefreshmen summer programs described above that can affect the retention rates of minority students. A number of engineering colleges sponsor pre-co-op programs with interested industrial companies to provide an opportunity for students to work in engineering-related jobs (usually as technicians or assistants).

Effective alternatives to the prefreshman summer programs are special programs for high school juniors and seniors conducted by engineering colleges that provide instruction in math and science subjects to supplement their regular school work. Classes and seminars for this supplemental work are provided by the colleges in the summer following the junior year and on Saturdays during the school year.

TABLE 9 Prefreshmen Summer Programs

Length of Programs		Program Components	Greatest Impact on Retention
More Than Eight Weeks:	3 colleges	Algebra Trigonometry	Calculus
Eight Weeks:	4 colleges	Precalculus Calculus	Campus Orientation
Six Weeks:	2 colleges	Chemistry Physics	Chemistry, Study Skills Building
Five Weeks:	1 college	English/Communications Skills, Computer Programming	Engineering Orientation
Four Weeks:	3 colleges	Slide Rule Reading/Study	Peer Tutoring and Counseling
Two Weeks:	6 colleges	Diagnostic Tests Engineering Orientation	
Less Than Two Weeks:	2 colleges	Campus Orientation Enrolled Students as Counselors/Tutors	
No Program:	13 colleges	Grants to Offset Loss of Summer Earnings, Industrial Visits	
Partial College Credit for Course Work in Program:	7 colleges	Placement Tests Visits by Industrial Representatives Drafting Work Experience/Pre-Co-op	

The Minority Introduction To Engineering (MITE) is a one- or two-week program sponsored by the Engineers' Council for Professional Development for potential minority engineering students. Students who have completed the junior year of high school and who may have an interest in engineering are eligible for participation in the program. The program is designed to expose the students to the field of engineering for the purpose of increasing freshman engineering school enrollments. MITE allows the students to become acquainted with the various fields of engineering, to experience a sample of college life, and to receive typical engineering classroom instruction. In the summer of 1976 over 1,300 students participated in MITE programs.

Precollege Programs and Engineering Retention

The key elements in the retention equation for minority engineering students are motivation for the study of engineering, math preparation prior to matriculation as an engineering student, chemistry and physics preparation prior to matriculation, and the academic performance after entry into the engineering program. Improving the quality of the motivation and academic preparation of the students before they begin the engineering program can help their academic performance while in the program. Precollege programs should therefore provide one of the most effective methods for improving the retention rates for minority engineering students. (Few objective analyses have been reported that confirm this, but most of the minority program directors reported that from a subjective viewpoint the programs work). Special high school programs, pre-co-op programs, prefreshman academic summer programs, and prefreshman campus and engineering orientation programs can begin to fill the voids in the prior experiences of minority students' academic preparation and knowledge of engineering. The programs can help develop more sophisticated students who are better equipped to withstand the demands of an engineering education.

Motivation for a particular field by an individual can occur only if that individual is knowledgeable about the field. It is widely held that members of minority communities and minority high school students have a limited knowledge of the educational and professional opportunities in engineering. The shorter precollege programs previously described are an excellent means by which potential engineering students can increase their knowledge, motivation, and preparation for engineering. The activities in the prefreshman motivation and orientation programs through which the students can understand the nature of the engineering curriculum—the pace, the rigor, the competition, and the demands upon one's time prior to their actually beginning the program, prepare them mentally for meeting the challenges head-on.

While the shorter programs are designed primarily to be motivational in character, the longer programs have as their primary mission the upgrading of academic skills. When properly designed, the course work provided in prefreshman academic summer programs can provide the exposure to and command of the math and science material that is essential preparation for the freshman engineering courses and decrease the differences in preparation between minority students and their nonminority peers. Any compensatory coursework that the students can take before immersion in the rigorous and fast-paced curriculum reduces students' problems once the school year has begun.

Without these special prefreshman programs, the compensatory work would have to be taken in tutoring sessions, for example, in conjunction with the regular engineering course work. The underprepared student is in effect doing "double duty." Not only does he have more work to do, but the time that he has available for his regular school work is reduced. To expect a student to compete on an equal basis under these conditions, with other students who don't have these problems, is unrealistic, especially at a school that maintains a rigid course schedule.

Not all of the students who attend prefreshman summer courses require remedial work or material not covered in their high schools. If the students have a good grasp of the necessary course work from high school, but attended a school in which a high level of competition did not exist, they may not have developed their reading, learning, and problem solving skills to their fullest potential. Academic prefreshman programs can provide the competitive environment, as well as the instruction to more fully develop these essential skills. In addition to the innate intellectual ability and motivation toward engineering, the ability to think, work, and absorb material quickly can be very important qualities in the academic performance (and subsequent retention) in the competitive engineering environment.

Participation in prefreshman summer programs for some students who do not need special or extra academic work can also be beneficial to the retention program. Even though they may not encounter academic problems, they may have personal problems that can be addressed before the school year begins. For those students who have come from communities that are extremely segregated, rural, urban, or otherwise different from the environment on the campus, the long summer program gives them the opportunity to begin the occasional difficult social adjustment before the onslaught of the regular school year activities. Individuals with severe family problems may also need the time and involvement in the summer programs to "get themselves together" to be able to devote their full energies to academic pursuits during the regular school year. For some of these students, a successful experience in the summer program can increase their confidence in themselves to do well in engineering.

The opportunity to earn college credit during the summer is sometimes available for students who do not need remedial work. Seven of the schools reported in our survey that students who attend their summer programs may earn college credit for their work during the summer, normally by taking one or two first-term courses. A benefit of this early start is that the students have an opportunity to work closely with one or more faculty member on a one-to-one basis. This can lead to a better mastery of the course material as well as the realization by the students that professors are indeed approachable and are interested in students.

The academic precollege programs for students that are still enrolled in high school can lead to dramatic increases in the retention rates at the engineering colleges conducting the programs. The students with the potential and interest to study engineering are identified in the junior year in high school. Early identification permits the students to select the appropriate courses that are preparatory for engineering in the senior year. Other benefits of this kind of program are as follows: the students establish a close relationship with the faculty members and administrators from the engineering college; the students have a longer time to absorb the extra subject matter in a relatively relaxed, but competitive, atmosphere; the students build academic competence and confidence, which will be important once they enter college; students gain a better understanding of the pro's and con's of the engineering education and profession, and those who decide that engineering is not for them can avoid even registering in engineering at the college.

There are also disadvantages to this kind of program. The students participating in the program are not obligated to matriculate at the school that sponsors the program, so the school may not get a return on its investment. The college and the participating high schools also must be physically close (programs are probably limited to urban settings).

The pre-co-op programs can also impact on retention. The jobs allow the students to earn and save some money, which can help reduce the financial problems in the following academic year. If the work experience is good it can be beneficial in that the students can: (1) obtain a firsthand, real-life knowledge about engineering as a profession, (2) begin the away-from-home adjustment and become more self-confident and reliant, and (3) become more motivated to remain in engineering. The students are normally offered job opportunities with the same companies in succeeding co-op work periods. The disadvantages of this type of program are: (1) students are sometimes too young to hold jobs in industry; (2) it is difficult for the employer to find meaningful, engineering related jobs for students with little or no engineering education; and (3) students who need remedial school work are not available in the summer to take it.

Ways to Improve Summer Programs

Those responsible for conducting the summer programs generally think that the programs can be improved to increase the retention rates of the students who attended them. Expansion of the programs by increasing their length by those schools with the shorter programs, and by increasing the number of students who participate, was suggested by a number of schools. The inclusion of academic course work was reported by those schools whose programs consisted primarily of motivational and orientation activities. Study skills were reported by several of the schools as an area of improvement in their summer programs.

The following are other ways that were suggested to improve summer programs: bring high school teachers with the students to the campus, better diagnostic testing techniques, more administrative and tutoring staff, external instruction in study skills into the academic year, greater involvement by minority professionals, reduce student-teacher ratio, maintain same discipline and structure of course requirements that exist during regular school year, and greater monitoring of students progress and financial assistance.

Need for Research

Almost all of those colleges that have precollege programs believe that the programs are responsible for improved academic performance, but very little data have been reported that confirm that these precollege experiences improve retention. Research and evaluation to determine the effectiveness of these precollege programs are needed.

EFFECTIVE RECRUITING AND ADMISSIONS

It has been reported that motivation for the study of engineering has the greatest positive impact on the retention of minority students. Adequate mathematics preparation follows closely as the next most important characteristic of those minority students who remain in engineering compared to those who drop out or are asked to leave. Efforts to improve the retention rate begin with recruiting and admissions procedures that bring to the campus those students who have strong commitments to engineering and solid math backgrounds.

In recruiting and admitting students, it is important that the probability of their remaining in a particular school be evaluated. This assessment should take into account the location of the school, the availability of financial aid, the flexibility of the program, the level of academic competition, and the effectiveness of available supportive services, as well as an evaluation of their academic abilities.

Recruiting

Accompanying the growth in interest and activity to increase minority student enrollment in engineering over the past few years was a growth in the sophistication of recruiting techniques. In the early stages of development of the effort, some of the colleges literally recruited students "off the streets" with little evaluation of their chances of graduating. After some disastrous starts, these schools developed better recruiting and supportive service programs. Recruiting techniques that appeal to the students that are generally qualified to be retained and graduated are now employed by those colleges that have genuinely attempted to serve minority students. What is clear is that effective recruiting can minimize later problems in screening and selecting students for the college.

For the minority engineering programs surveyed by the Task Force, the methods used for recruiting and their frequency of usage on a percentage basis were reported as follows:

Recruitment by Currently Enrolled Minority Students	92%
Minority Program Staff Members Make Personal Contact Through High School Visits or Telephone Calls	85%
High School Visits by Minority Faculty/Staff	82%
Send Letters to Students from ME^3 List (Minority Engineering Education Effort)	75%
Recruit those Students who have Participated in Precollege Programs (e.g., MITE, Saturday Morning Programs, etc.)	71%
Send Letters to Students from CEEB (College Entrance Examination Board) Student Search List	67%
Send Letters to Students from ACT (American College Test) List	57%
Special Program to Bring Minority Admission Candidates to the Campus Sometime During Their Senior Year	50%
Send Letters to Students from National Achievement Scholarship List	46%
Other	7%

Admissions

Listed below are some of the comments taken from the survey instrument that characterize the different school policies concerning admissions.

1. Our CEEB program does not believe that the admissions policy makes a significant difference, unless an exceptional supportive services program is in effect.
2. We have no special admissions policies. Minority students should, and do, have to meet the same admissions and testing criteria as all other students.
3. Our institution would oppose the lowering of admissions standards because we believe that retention rates would decline and we would damage the student.
4. We would advocate no changes within our current admissions policy. In conjunction with our admissions policy, however, we believe that we should maximize funds for a continued thorough analysis of each student who is entering the university.
5. Our current open admissions policy does reduce our retention rates, but it allows a significant number of students to attend the university who would otherwise not be admitted and not have the opportunity to pursue an engineering degree.
6. Retention rates probably could be improved by requiring overall higher grades and test scores, as well as by confirming a strong commitment to engineering, but this would reduce the opportunity to some who have started in engineering, but succeeded in other programs.

The exact relationship between admissions and retention has not been proven, but the retention rate for minority engineering students could probably be improved if only those students with strong commitment to engineering, high test scores, and the best-possible math preparation were admitted. A number of schools actively involved in the minority effort adhere to this philosophy and are opposed to using admissions standards for minority students that differ from the standards used for nonminority students, because retention would probably decline. Other schools with open admissions policies oppose raising their admissions standards because this would reduce the opportunity for the type of student that does not display the traditional engineering student qualifications but has the ability to be successful in engineering, or some other program.

The dilemma caused by the relationship of admissions and retention versus the desire and/or need to make engineering education accessible to larger numbers of minority students has led to adjustments and refinements of admissions procedures that give special attention to the applications of minority students. This special attention is in response to the recognition that standardized test scores may not be good measures of the true abilities of minority students. Additional measures, described later, are therefore used in conjunction with the traditional measures for selection. Though minority applicants receive a more extensive review, most of the schools with these procedures do attempt to admit minority students whose academic preparation most closely resembles that of the traditional entering freshmen.

Schools that have special admissions programs that enable students to enroll who otherwise would not qualify for admission, or who are marginally qualified, provide special tutoring programs for those students through the college of engineering. Institutions with special admissions programs should feel obligated to provide the services that special students require to enhance their probability of successfully completing their engineering programs. Tutoring is only one of the important elements of the comprehensive supportive services programs that the schools should provide to any specially admitted students. It is indeed unjust for an institution to admit a student, knowing that the student has particular academic weaknesses, and then leave the student on his own to try to compete with his classmates without any help from the institution.

An important aspect of admissions, other than the selection process, is the number of minority students at each of the predominantly white colleges. Most of those schools have found that the success rate of their minority students has increased after a critical mass of students are enrolled. The reason for this may be for any or all of the following: (1) the more students that are admitted over a number of years, the more experienced the admissions officers become in selecting students who have the appropriate characteristics for doing well in the program; (2) the faculty members become more sensitized to the special problems and needs of minority students; (3) the minority upperclassmen serve as role models or examples that minority students can be successful on a given campus; (4) there are enough minority upperclassmen to (formally or informally) assist in the advising and tutoring services for the younger students; (5) the more minority students in any given class means greater opportunities for peer support; or (6) if the number of minority students reaches a certain level, it is a signal to them that the school is truly committed to minority student education.

Standardized Test Scores

There is great variety in the opinions presented on the validity of standardized test scores for predicting the success of minority engineering students. Several of the schools in the study have recently found that test scores are valid predictors for minority students who attend there. Many of the opinions were that test scores are helpful tools for guidance in admissions decisions, but that other variables must be scrutinized to reach a reasonable determination of the students' capabilities. The other variables are more subjective in nature and are usually assessed through personal interviews with the students, more extensive information from high school counselors and teachers, and contact with the students through special precollege programs or numerous meetings.

For those schools that have found that test scores should be supplemented with other measures in making admissions decisions, the following list of references was reported as being of greater value: high school rank in class (8); personal characteristics, including those projected in interviews (6); high school grades (5); high school physics grades (4); high school chemistry grades (4); recommendations (3); success in prefreshman (summer) programs (2); success in MITE-type programs (2); willingness to earn money (1).

Not all of the schools' experiences indicate that scores are not valid. One school reported that very few of their students with math ACT scores below 22 finish engineering. Another school has kept data since 1972 that show that entrance scores (primarily ACT) are valid predictors. At that school minority students with high scores (above 23) or low scores (below 15) progress at the same rate as nonminorities with comparable scores. However, minority students with marginal scores (15-18) are more likely to stay in school and complete degrees than nonminorities with marginal scores. Another school reported that ACT scores are valid indicators provided the student is not placed in direct competition with all high achievers and carry the same academic load during the first semester. For this college, the high school rank tends to be the best predictor if the ACT is above 20. Finally, one school has established correlation factors relative to the use of ACT scores in comparison to college grades as follows: total university +0.52, college of engineering +0.54, total minority +0.37, which indicate that ACT is not as valid for minorities as it is for the total university population. Part of the problem in determining the validity of standardized test scores for predicting academic performance is that at some schools the number of minority students is so small that reliable correlations cannot be computed.

There is a substantial body of literature that has established that standardized test scores are valid predictors for performance (GPA) of minority and educationally disadvantaged students. Stanley (1971) reported that test scores predict the college grades of advantaged and educationally disadvantaged students almost equally well, but that high school grades improve considerably the predictions for both groups. Stanley and Porter (1967) found the SAT an almost equally accurate predictor for college grades for black and white students in segregated colleges. Cleary (1968) found homogeneous regression systems for blacks and whites in integrated schools, but Temp (1971) found that regression systems for prediction of college grades were nonparallel for black and white students. Goldman and Hewitt (1974) found that the SAT does not add much to the prediction of college grades by high school grades for Mexican-Americans.

While studies have shown that standardized test scores are reasonably accurate predictors of academic performance, they do not necessarily predict a student's persistence or retention in school. Students who are predicted to earn low grades within a particular school will tend to have academic difficulties if enrolled there, but there are many instances of students who were predicted to have poor performance who were very successful because of their personal drive/motivation and the supportive assistance of their colleges.

The reasons for the difference of opinion on the validity of standardized test scores for predicting success may be directly related to the availability and use of supportive services by the students with low scores and the flexibility of the college to individualize student course schedules. Colleges at which low scoring students have been successful probably have effective supportive services and are flexible enough to match the students' programs with their current capabilities. Colleges at which low scoring students have been generally unsuccessful may be schools that have no effective services or have rigid academic schedules.

Ways to Improve Recruiting and Admissions

Recruiting minority students that tend to do well at a particular college can sometimes be a difficult and expensive (but necessary) process. The ultimate retention rate of the students that matriculate at a particular school will largely be determined by the basic abilities (and potential) of those students at their point of entry into the program. Since recruiting and admissions are important variables in the retention equation, they deserve detailed attention to optimize a college's minority student retention. In addition to improving the efficiency of those methods mentioned earlier, the following suggestions may be useful methods of improving the recruiting and admissions process:

- Identify source(s) of those minority students that are currently enrolled and determine whether more attention should be devoted to increasing the number of new students from that source.
- If possible, persons involved in recruiting and those making admissions should be the same. If they are not, then they should work closely together.
- Develop and maintain communications with science and math teachers at secondary schools from which students qualified for engineering graduate. These teachers can identify and facilitate communications between their top students and the college.
- Provide honest and accurate descriptions to prospective students of the college, the campus, and what will be expected of the students.
- Establish formal or informal programs with local or nearby secondary schools. (Faculty members may give regular guest lectures in math and science classes. The Admissions office can sponsor tours of the campus, for science and math teachers and students. The college may sponsor an Engineering Explorers scouts program or JETS' program for high school students.)
- Identify, as early as possible (tenth or eleventh grade), those students who are potential admissions candidates and maintain contact with them throughout remainder of their high school program.
- After the top admissions candidates have been identified, personalize communications with them through letters and phone calls. Department chairmen should also write to them.
- Encourage admissions candidates to visit the campus.
- Many minority students select a school to attend that has a good minority program, a relatively large number of minority students, or a good reputation for commitment to minority student education. If a school has a good track record with minority students, others will follow.

CURRICULUM FEATURES

Placement

An important factor in the academic success of students is entry into a subject at a level that is most appropriate based on the students' backgrounds. Particular care is needed in the proper course placement for those students who have been admitted to a college through a special program.

Methods of placement vary but generally include one or more of the following: placement tests, diagnostic tests, scores on ACT or SAT, high school grades in individual subjects, performance in prefreshman summer programs, courses taken in high school, interviews and counseling sessions, and review by faculty advisors.

The Task Force questionnaire asked the question, "What mechanisms do you use to enroll minority students in different course levels in their first semester?" The responses were as follows:

1. We require placement examinations of all entering students for mathematics and chemistry.

2. We believe that a program of testing and diagnostics is helpful to determine the level at which students should enter our university. For all students, summer meetings and/or a new student week offer opportunities for testing and advising sessions to determine the appropriate entrance to mathematics, chemistry, physics, and the language sequences.

3. We have no special remedial courses as such, but with careful advising, freshmen can stretch out the first year of their first semester courses throughout the entire freshman year. Also, we provided reteaching sessions or repeats of information during the afternoons and evenings, which are open to all students. (This approach is a good one because it allows the students a given amount of time to adjust to the curriculum, as well as to self-pace themselves through what is a very difficult transition.) In that it is provided for all students, we believe that it provides a tremendous impact on retention, not only for minority engineering students, but for all students.

The following options should be considered by the individual programs as a means of providing the opportunity for entering students who are not yet ready to undertake a full course load to experience success in the engineering curriculum: (1) meetings with faculty advisors; (2) developing course schedules for students at the beginning of the semester that will be used throughout the students' college careers; (3) using the summer minority engineering program as a training and testing ground for all entering students; and (4) using "stretch-out" and providing students with the option of taking 12 credits per semester.

Areas that should be highlighted are those areas found in programs which use the idea of curriculum stretch-out, summer programs, diagnostic testing, and the advising and counseling to place the student in the correct courses. The most innovative idea is probably that of curriculum stretch-out. While it is recommended that stretch-out and the other ideas outlined above be used, caution should be exercised against counseling students into stretching their curriculum past the five-year period that is normally experienced for minority engineering students.

Learning Support Programs

In addition to the introductory courses in math, chemistry, physics, and English, self-paced instruction and learning laboratories are other means through which colleges are attempting to meet student needs following an assessment of their preparation. Though the objective studies have generally not been conducted by the colleges to determine the effectiveness of the special courses, laboratories, and skills centers in improving the academic performances of the minority students who used them, it was the subjective opinion of most of those who responded to this subject that the services were beneficial to the students (see Table 10). Academic support centers outside of the engineering colleges (e.g., reading and study skills centers) can complement the primary academic support programs (namely tutoring and academic advising) provided by the engineering college programs.

While most engineering colleges apparently have not objectively analyzed the benefits of their academic support programs, studies have been done that indicate their importance for high-risk students. Louis Nieves (1976) referred to a study of high-risk students who graduate that concluded that the key elements to successful graduation for this group were study habits and academic skills. According to Paulsen and Stahmann, it can be deduced from that study that it appeared that the acquisition of these habits during the college years appeared to be the most significant factor in assuring graduation. Citing additional studies, Nieves concludes in his paper:

> The implication of these findings is that they would lead us in a direction of emphasizing strategies for academic achievement: teaching minority students how to study, when to study and what to study, rather than trying to compensate for hypothetical, ambiguous, and vague intellectual deficiencies. These findings imply directions away from efforts to "enrich" the minority student or increase his appreciation for learning and its intrinsic value and instead toward practical skills development efforts.

Astin (1975) also reports that students' ability to schedule their time and organize their work to meet a deadline for assignments relate to college persistence.

TABLE 10 Learning Support Programs

Learning Laboratories, Self-Paced Instruction, Reading and other Skills Instruction	Compensatory or Remedial Courses	Evidence that Learning Support Program Improved Academic Performance of Minority Students
1. Self-paced courses in math, physics, electrical engr., chem. engr. Mini courses in mechanics and mechanical engr. Learning lab in chemistry. Learning Center (University-wide). Developmental Reading Course and Reading Clinic.	1. Courses not remedial, but based on great diversity in backgrounds and courses taken in high school require equally diverse math, chemistry, physics and English courses. However, we do offer a counselor-tutorial course during the freshman year for students with weakest math and science background.	1. Increase in retention years due at least in part to counselor-tutorial program. Also increase in CPA index, especially in counselor-tutorial programs.
2. Remedial reading and math in pre-freshman summer program.	2. Learning Skills Lab is available to students with difficulty in the three basic learning areas: reading, writing, and math.	2. Students who use Learning Disability Center have experienced great results. In most cases by backstepping awhile they are able to again resume their original academic goal and attain their chosen career.
3. Reading and writing laboratory.	3. All students are required to take a skill test in algebra and trigonometry. Deficiency in these areas requires that students enroll into a six hour per week calculus course rather than the four credit hours.	3. Evidence points to the fact that all students who are deficient in skills of algebra and trigonometry are benefitting from this experience. Lower attrition rate in later calculus courses. Reading and Writing Laboratory—insufficient data at present.

4. There are facilities and staff in the areas of reading, writing, and math, including calculus.	4. Courses exist in writing and mathematics, suitable for *all* students.	4. By reducing problems and increasing subject area knowledge, students are being retained who simply would be completely ill-prepared to handle college work.
5. Learning lab with video tapes, cassettes, etc.	5. High School algebra and trigonometry. English compositions. General physics. "High School" drafting. General chemistry.	5. Interviews with students reflect favorably on this approach. Without a control group, we cannot fully assess the improvement.
6. CAR has traditional classes as well as self-paced instruction, skills instruction, and group counseling.	6. The university operated a Center for Academic Reinforcement (CAR), which provides remedial work in verbal, mathematics, and learning & study skills. Students receive one semester hour of credit for each component completed satisfactorily.	6. Since CAR is new and few of our students have enrolled in it, we do not yet know how it has affected engineering students.
7. Auto-tutorial and self-paced backup materials in mathematics, chemistry, physics and mechanics are available. However, these materials do not find frequent use. Preference is for working directly with tutors.	7. Algebra, trigonometry, chemistry, and writers workshop.	7. Impossible to attain the normal starting point in required mathematics and sciences without these "bridging courses." Understanding and confidence are improved in special instruction and tutoring arrangements.

Monitoring of Student Progress

In order to reduce the incidence of poor academic performance or failure, especially during the freshman year, it is important that the student's performance in the classroom be monitored to detect areas of trouble before it is too late to rectify problems. The schools in this study have a variety of mechanisms for monitoring. Several of the colleges have structured methods that include formalized trouble reports from instructors, six-week progress reports, and mid-term reports for those doing poorly. Faculty members at some of the colleges inform students when their work is unacceptable before the term ends. A less formal, but often effective, system, which notifies the minority program staff when a student is having trouble, is the student "grapevine" or word-of-mouth. This can be very effective when students with problems avoid seeing their instructors and advisors or avoid seeking assistance through other means.

The most common responses to students who are encountering academic problems have been to encourage the students to obtain intensified tutoring or to reduce their course loads. Often students' poor academic performances result from personal rather than academic problems. In these situations personal counseling to identify and help alleviate the problems has proved successful. Other approaches to this situation have been to stretch courses over a longer period of time or to schedule "reteach" sessions.

Reduced Course Loads

Most of the schools responding to the survey indicated general agreement that reduced course loads, especially during the freshman and sophomore years, benefited minority students' chances of completing the degree program. However, views varied on this matter. For those students with areas of deficiencies in their backgrounds, two private colleges have four-and-one-half-year and five-year structured programs that spread required courses in an organized manner across the total college years. These planned programs allow students to work at a pace that is more suited to their needs. These programs can reduce the incidence of failure and underachievement and possibly the resulting blows to the students' self-confidence and motivation. The notion behind this approach is that it is better to learn a few subjects well rather than a large number of subjects poorly.

While most of the schools indicated that reduced course loads are beneficial to minority student retention, some reported that reduced course loads may be beneficial to any of their students, depending on their educational backgrounds and academic, personal, and financial pressures at any given time. Other schools discourage reduced course loads for any of their students because: (1) the schools do not want students to get used to a reduced work load; (2) taking reduced loads often results in having required subjects offered in the same time slots in the students' schedules in future terms; (3) some of the faculty at the school think that, if students cannot perform satisfactorily under the conditions of a full academic load, they may not be able to perform satisfactorily as professional engineers upon graduation from school. Table 11 shows the percentage of schools that permit reduced course loads.

It should be recognized that participation in tutoring programs does require time, which is a precious commodity to engineering students with heavy course loads. If a particular student is obtaining tutoring in several courses on a regular basis, that student will naturally have less time to devote to assigned course work. If adjustments in the student's work load are not made, the school is in effect putting the student in a more disadvantageous position, rather than helping the student. The student has more to do with less time to accomplish it. A useful approach to establish a student's academic program, including his tutoring needs, is to make an honest evaluation of the student's individual capabilities considering his high school experience and performance in the prefreshman program, if any. The key is not to put a student in a situation where his chances for success are slim.

TABLE 11 PERCENTAGE OF MINORITY STUDENTS WITH REDUCED COURSE LOADS, 1975-76

	Fr.	Soph.	Jr.	Sr.
Public Schools [a]	46	30	29	27
Private Schools [b]	33	20	15	11

[a] Averages for 13 schools. Six schools did not answer the questions. One school's requirements are flexible such that there are no reduced loads. One school had no reduced loads. Another college estimated that 75-80 percent of the freshman and 50-75 percent of the sophomore students in the special program for disadvantaged students took reduced course loads. Range: Freshman 80-0 percent, Sophomore 64-0 percent, Junior 55-0 percent, Senior 75-0 percent. This does not include the predominantly black schools of engineering.

[b] Averages for five schools. Five schools did not answer. Two schools had no reduced loads. Range: Freshman 90-0 percent, Sophomore 40-0 percent, Junior 37-0 percent, Senior 25-0 percent. This does not include the predominantly black schools of engineering.

Other Curriculum Adjustments

In addition to the standard method of adjusting the students' academic schedules by reducing the number of credit hours required each semester, several schools have tried variations of that method. At one private college there are no special or remedial courses as such, but with careful advising freshmen can stretch out the first year or stretch the first semester courses throughout the entire freshman year. As part of the program "reteaching sessions" are taught during afternoons and evenings and are open to all students. Another school has similar provisions: All students there are required to take a mathematics skill test in algebra and trigonometry. Students who cannot perform at a minimum level are required to take a six-hour course in calculus rather than the four-credit-hour course. The additional two hours per week are devoted to algebra and trigonometry taught by the faculty member that teaches the calculus course.

A large number of minority engineering students take some course work in the summers. From estimates provided by 21 of the schools responding to the survey, 28 percent of the minority engineering students enrolled in 1975-76 had attended summer school the previous summer. Eleven of the colleges did not answer this question or did not think it was applicable. Of the 21 schools responding, 6 reported that 10 percent or less of the students attended summer school, 5 reported more than 10 percent but less than or equal to 25 percent, 9 reported more than 25 percent but less than or equal to 50 percent, and finally 1 of the schools reported that more than 50 percent of its minority students attended summer school in 1975. Another school reported that 50-75 percent of the students in the special program for disadvantaged students had attended school in the summer of 1975.

Some students who attend summer school do so to retake courses they were not successful in the previous academic year. Others do so as a result of a structured, prearranged schedule so that they can have the opportunity to take reduced loads during the regular academic freshman and sophomore year. The latter situation is a much more efficient one in that: (1) underprepared students have fewer subjects to study at one time and can devote more time to intensive study of those subjects that probably enhances their performance in them; (2) some courses (those that were failed the first time) would not have to be taken twice; (3) more individual attention, by professors and tutors, can be given to those students in summer school; and (4) the trauma that results from failing courses and the pressure of having more work at one time than the students can successfully handle are reduced.

Even though there are benefits in attending summer school, there are reasons why extensive use of the summer terms for course work may not be appropriate for some students. Some students need a break or vacation from the intensive work schedule. If students attend a pre-freshman summer program and go to summer school after their freshman and sophomore years, they would have been in school for three full years without a real vacation by the end of their junior year. Also attending summer school prevents them from gaining the experience and earnings from summer jobs.

In order for summer courses to serve as an important segment of an effective retention program, financial aid should be as readily available during the summer as it is during the regular academic year. Seventeen of the schools participating in this study reported that they provide financial aid to those minority students who attend summer school. Two reported that the financial aid is provided in limited amounts. Seven of the schools reported that they did not provide aid for summer students, while six of the schools did not respond to the question or reported that the question did not apply to them.

It is interesting to note that five of the schools that reported that summer school could be effective in a retention program did not provide financial aid. Presumably these schools did not have the resources to provide the aid. Three of the schools that thought that summer school was not an important part of a retention program did provide financial aid for those students who attended. Two of the schools whose representative did not think summer school was an effective retention program element did not provide aid for those students who took summer courses.

TUTORING

Tutoring has been recognized as one of the most important ingredients in an effective retention program for minority students. Engineering colleges generally provide tutoring through various means for their general student bodies to complement the classroom teaching, but tutoring is especially important for those minority students whose prior academic preparation in the crucial math and science courses has been generally poorer than that of their fellow engineering students.

The need for tutoring can be verified by referring to several facts obtained in this survey. The engineering college at a large midwestern technical school, which has an extensive freshman engineering program, spent $32,000 in 1975-76 for its tutoring program for the 179 minority students that were enrolled during that year (an average of $179 per student). The students in the freshman class were the ones that had the greatest need for those services. The engineering college at a medium-sized private college expended approximately $19,000 in academic year 1975-76 for the 85 minority students enrolled that year ($224 per student). Again, the students in the freshman class were the largest group of students who availed themselves of the tutoring services, with over 50 percent utilizing the services. A large public technical school in the East estimated that about $18,000 was spent in 1975-76 for tutoring and the tutoring coordinator. The total minority student enrollment was 217 for that year ($83 per student).

At four of the institutions responding to our survey, utilization of the tutoring services was mandatory for all the freshman minority students. At another institution about 30 percent of the 1975-76 freshman minority class were required to attend tutoring sessions. These schools have taken the sometimes difficult position of requiring tutoring for some of their students. Students do not always do things that are in their best interest and oftentimes are reluctant to take advantage of the tutoring that is provided. Convincing them of the need for tutoring can be a challenging task and one that a faculty advisor or program director often finds very difficult.

Seventeen of the public schools participating in this study estimated that more than 25 percent of their minority freshmen in 1975-76 used the tutoring provided at their colleges. Two of those schools estimated that more than 50 percent of their minority freshmen students were tutored. Two of the private schools in this study reported that more than 25 percent of their freshman minority students used tutoring services in 1975-76.

In most cases the continued need for extensive tutoring throughout a student's undergraduate program can be an indication of: (1) inadequate utilization of the supportive services in the freshman and sophomore years, (2) an improper match between the student and the school, (3) the student's not applying himself adequately to school work, or (4) the gap in academic skills between the underprepared students and their classmates was not effectively eliminated or reduced in the first two years in the program. If the need for tutoring does not diminish for a large number of minority students as they progress from year to year (and particularly in the senior year), it may be a signal that the admissions policy for the minority students needs to be reexamined or that the tutoring program is inadequate or underutilized in the early years at the college.

Both students and staffs, where appropriate, should realize that tutoring is not a necessary evil that interferes with or disrupts a student's progress through the educational program. It is instead a complementary and integral part of the educational process for those who would benefit from it.

Tutoring programs have different structures. Several schools reported having extensive, structured, institutionalized tutoring programs for all students from which minority engineering students can find the specialized tutoring programs they need. Minority upperclassmen serve as tutors for the younger students at all but four of the schools responding to the survey. Minority upperclassmen are by far the most frequent and effective source of tutoring at the colleges. Several of the schools report that this tutoring has been even more effective for them when the tutors are paid rather than serve in a voluntary capacity. The upperclassmen tutors in a one-to-one capacity with the underclassmen, in group tutoring sessions, as well as through the minority student organizations in a less formal way. Minority or nonminority graduate students have also been very effective sources of tutoring at several schools. These students are often hired as teaching assistants whose sole responsibility through those positions is to tutor undergraduate students.

Members of the engineering faculty were reported as being one of the most common sources of tutoring for minority students. It was generally not reported through what mechanism this tutoring was provided (i.e., formal or informal, as a part of regular course work responsibilities, or at the voluntary initiation of the professors), but it is assumed that it is generally on an informal basis. The structured tutoring program at one school has engineering faculty members in a formal capacity as the primary source of tutoring manpower. Several schools have found that a tutoring program that combines upperclassmen and faculty members in a structured way can lead to more effective tutoring programs. At two private, technical institutions some members of the minority engineering staff were members of the faculty, and these individuals also did some tutoring of undergraduate students.

At many engineering colleges honor societies and fraternities provide programs that are available for all engineering students. It is not known to what extent minority students use these services, but none of the schools responding to the survey instrument reported it as the most effective component of their tutoring services for minority students. Other sources of tutoring were reported to be professional engineers by three schools.

One of them also indicated that recent minority graduates of the school provide some tutoring for undergraduate students.

ADVISING AND COUNSELING

Sources of Services

Personal advising and academic counseling are services that most of the engineering colleges provide for their students. The mechanisms for providing these services are generally the same from one campus to another, but their effectiveness varies from campus to campus. Advising and counseling services are usually available to all students from one or more central university office(s). For the universities with a campus-wide minority program, advising and counseling services for minority students are generally available from the university minority program as well. Engineering colleges have found for both their general student body and their minority students that the central university services must be supplemented with those provided directly by the college. These supplemental services are provided through engineering faculty advisors, structured college tutoring and advising centers, graduate assistants, upperclass students, minority program directors and staff, engineering honor societies, student chapters of professional societies, and minority student engineering clubs.

Effectiveness of Services

According to responses in the survey instrument the minority program staff provided the most effective advising and counseling (14 responses) for minority students. Peer counselors and faculty members each received five responses as the most effective sources of the services. Several of the colleges reported that no single source of the services was more effective than the others, but that the combination of them was effective. One private college reported that its structured Institute Counseling Program was the most effective and another reported that the college's provisions of closely advising all students in combination with peer counseling was the most effective. One of the predominantly black engineering colleges reported that the engineering counselor was the source of the most effective counseling.

At the predominantly white campuses the minority program staff are more effective for both real and perceived differences by the students than the other sources of advice and counsel. Minority program staff members often develop a personal one-to-one relationship with minority students through extensive recruiting contacts or prefreshman summer programs. Their knowledge of the students' strengths and weaknesses gained through the contact with them over this period of time, coupled with the general knowledge of how other minority students with similar academic backgrounds have fared at that institution, places them in a unique position to help the students select the courses (if options exist) that are most appropriate for them. The students are also more willing to discuss personal problems with the staff members if the students have developed trust and confidence in them in this prior contact. Minority students are also apt to be more receptive to advice of the program staff if the staff calls special meetings of all the minority students and meetings with individual students, so that the staff members see the students more often than regular faculty advisors during the school year. A very basic reason that staff members have better advising relationships with the students is that they often share common ethnic and cultural backgrounds. Some of the colleges with large groups of minority students from different ethnic backgrounds have counselors or staff members from each of the ethnic groups.

Minority upperclassmen are effective counselors because of their ethnic and cultural background similarities with the younger students. The upperclass students can often provide tips for successfully completing courses and can advise the younger students which professors and courses (if options exist) to avoid because of their own bad experiences with them. Minority upperclass students who develop a close relationship with their advisees can inspire them to have a more optimistic outlook about their work, since the upperclassmen stand as proof that minorities can be successful at that particular school.

Minority staff and minority upperclass students can be more helpful to their advisees for other reasons. Many times the students tend to blame their personal and academic problems on what they perceive as the racist nature of the institution. When this is carried to an extreme, the students have an excuse for not working to their fullest potential. The minority advisors are in a better position to help their advisees make a more honest assessment of the extent to which racism is an important factor. Often nonminority faculty advisors are reluctant to question their minority advisees about such matters and therefore are less able to provide discipline and direction when necessary.

There are several other reasons why nonminority faculty advisors are sometimes ineffective counselors. Many of them are inaccessible in that they do not keep their office hours, or they give the impression that their time is too valuable to spend discussing a student's individual problems. Some minority students are reluctant to seek out their faculty advisors because the advisors seem to be too impersonal or hostile toward them because advisors think all minorities are unqualified for their schools. Because of this perceived attitude of the faculty advisors by the students, the students will avoid any contact with the advisors when encountering academic problems. They assume that consulting with their advisors will only reinforce the negative opinion the advisor already has of minority students. These students do not realize that many of their nonminority classmates consult their faculty advisors often and that doing so does not automatically reduce the advisors opinion of them.

Improving Effectiveness of Services

Counseling can be made more efficient if it can be less formal and structured and more personal. Advisors that project an image of real interest and concern for the students' problems will be more helpful to them. A balance between being too lenient or noncritical and being too heavy-handed and unsympathetic is the best way of being helpful to the students. An awareness that minority students often can have more different problems than majority students should be useful in providing the proper guidance to advisees. Knowledge of the possible curriculum and course options, deadlines for dropping or changing courses, other policies of the college, and other sources of supportive services around the university will enable the advisor to be of greater help to the advisees. One possible trap that the minority program staff members should avoid is to think that they can answer all of the advising and counseling needs of their students just because of racial similarity. Often times students have severe emotional/psychological problems and the advisor should be wise enough not to try to handle the problems alone. Sometimes detailed questions about academic matters are beyond the knowledge of the advisor, and the advisor should seek additional expert (from the proper department) help rather than guess at the solution.

MINORITY STUDENT ORGANIZATIONS

Twenty-two of the 29 predominantly white engineering colleges that participated in this survey reported that there were minority student engineering organizations active on their campuses. Most of these schools reported that these organizations were impacting in a positive way on the retention of the student members. The benefits of the organizations include the following: (1) the organization can provide a means for small group identification so that the students do not feel lost among a large group of people, (2) students have an opportunity to meet regularly to share common problems and possible solutions to those problems, (3) the organizations on some campuses are the means by which informal tutoring and counseling by the upperclassmen takes place, (4) the organization provides a quick means for the program director to communicate with many of the students on matters important to them, (5) for some students these organizations provide the only professional identification while they are in school because they do not participate in the student chapters of the professional societies, and (6) the organizations function much like the fraternities in that they can compile files of old homework assignments, notes, and laboratory reports that serve as valuable resource material for their members. One of the respondents to the survey instrument wrote "the group's interaction has caused an awareness of the expectations of the University and society and hence academic performance has improved. In general, however, these groups tend to improve motivation more than academic performance."

Professional Societies' Student Chapters

The majority of the respondents to the survey instrument stated that greater participation in the student chapters of the professional societies by the minority students would have some positive effect on their retention in the engineering program. Reasons cited for this belief were peer identification, mutual help, early identification of problems, company and professional contacts, and job referrals. Students would be exposed to their own engineering disciplines at a professional level and could become more aware of industrial demands. This better understanding of their particular field of engineering would reduce the fear of being unable to perform within the field. Identifying with the engineering profession and becoming involved in the mainstream of student activities should also ease the transition from college life to that of the professional environment where one would probably have to work with engineers of all ethnic and social backgrounds. Three of the schools reported that greater participation in the professional societies by minority students at their schools would not necessarily have a greater impact on the minority students, since they already tend to participate and hold office to the same degree as nonminority students at the present time.

At the predominantly black schools and those with very large percentages of minority students, the student chapters of the professional societies and the minority student engineering organizations do not always co-exist, because the peer support, leadership opportunities, professional activities, etc., would be available through either kind of organization and there would be no need to duplicate them. Neither kind of student organization can be helpful unless: (1) it offers some tangible benefits to the members, (2) a significant number of students actively participate, and (3) the organization has the support and commitment of the school's administration and faculty. A potential negative effect from the organizations exists for many student activities in that a student may devote too much time to the organization which would be to the detriment of his schoolwork.

Increasing Impact Upon Retention

The minority student organizations can become more important contributors to the minority programs and the minority retention rates with greater support from the colleges and the minority program directors. The support could come in the form of funding assistance, program planning assistance, and creative thinking to design an organization that appeals to a large number of the minority students who will become active participants.

FACULTY INVOLVEMENT

Before discussing faculty attitudes, some comments from the Task Force questionnaire are very helpful in outlining the areas in which various universities are trying to provide interaction between faculty and students. The following are typical of the responses which were received on the Task Force questionnaire:

1. The faculty are highly student-oriented and provide a tremendous amount of valuable student instruction. This instruction is provided in and out of the classroom. By considering the students as engineers first and minorities second, the students' self-images are enhanced.
2. We hold a firm conviction that minority students should not be placed in a separate group during their university career. We encourage all students to think of themselves primarily as engineers rather than Mexican-American engineers, black engineers, or native American engineers. We have found the adjustments to college life and the approaches needed for recruiting, counseling and tutoring vary much more due to the different urban/rural background that a student has rather than with their ethnic backgrounds.
3. We have embarked upon a program to identify early-on the problems of minority and majority students so that we may better help minority students in providing counseling, scholarships, tutoring, etc.

In doing so, we have employed minority students and set up special offices for minority efforts. In setting up those offices and a corresponding strong public relations program, we have also encouraged participation with all ethnic engineering societies. This encouragement would not be possible without a strong commitment on the part of the faculty and administration.

4. We have a commitment from the top down to help in a very sincere way. This commitment must come from the chancellor down to the faculty and throughout the minority engineering program. The commitment of an administration and faculty of an institution of higher education to ensure the success of a minority engineering program is a vital key to unlocking the problems associated with retention and increasing the pool of minority engineers.

5. The minority engineering program at this institution was started with a minority student and a majority professor. This very unique dedication on the part of two individuals paved the way for one of the more successful programs in minority engineering. Commitment to the program is shown from the higher administration, through the dean's office, well into the faculty. This commitment has come in the form of dedicated time by professors, deans, and other professors on the campus outside of engineering to assist in all efforts of the program. This dedication has also come about without the extra amenities sometimes provided faculty in terms of release time and extra pay. The program has, since its inception, gone away from asking professors to provide tutoring and other services unless they wish to dedicate themselves voluntarily. The reader should know that the commitment that any professor makes, of his or her own time, without extra pay and/or release time, is a commitment above and beyond the normal requirements.

There are many ways in which faculty and administration can assist minority engineering program efforts. These efforts come in the form of tutoring, counseling, in- and out-of-class instruction, along with participating in the various events held by the minority engineering program.

Out-of-class instruction is very important for faculty to provide to minority engineering students. While most schools still believe that the minority engineering student will seek out professors for advice and counseling, many minority students still do not interact heavily with majority professors. Professors who use out-of-class instruction to reach students, ask questions to make sure that the student understands and provide on-the-spot short quizzes, and use the blackboard and ask the student to take the professor back through the problem, utilize some of the more effective ways of instruction techniques. These out-of-class instruction techniques can be utilized for all students. While this method of instruction takes a great amount of time, it is most effective in increasing retention and insuring that the student understands a process and/or problem. Because most attrition occurs during the first two years in engineering curricula, during the time that the student is taking courses in mathematics, physics and chemistry, it is critical that professors outside of the engineering faculty have more interaction with the students. It therefore becomes necessary that the professors in the physical sciences and mathematics courses also provide out-of-class instruction and participate with the minority engineering program. Funding should be provided for grants to the university curricula in mathematics, chemistry, and physics to provide out-of-class instruction, tutorial services, and other curriculum flexibilities that might be provided for minority students enrolled in engineering.

PART-TIME/CO-OP WORK EXPERIENCES

Part-Time Work

The colleges surveyed have mixed perceptions about the effect of student employment on student academic performance and retention. Some of the respondents to the survey reported that work experiences during the academic year definitely interfered with student performance. Others believe that the work experiences have a positive impact upon student performance. One school reported that no effect was observed for the good students, but the poorer students had some academic difficulty if they worked while attending school. Another reported that the positive and negative factors tend to cancel each other. Several schools reported that if the work is directly related to engineering, the effect is generally good; if the work is not engineering related, the effect depends upon the student.

Those schools that have observed negative effects of working generally agree that the work consumes time that should be devoted to academic pursuits. A small urban school reported that most of its students who work off campus perform very poorly in comparison to those who are on scholarship or work study. Generally, the jobs are not related to engineering and leave very little time for studies. For those students who experience greater academic difficulty upon working, the common response of the schools has been to reduce their course load accordingly. One college suggests that any student who works should reduce his course load by one unit for every three hours of outside work.

The majority of the schools reported that limited amounts of work experience, especially that which is engineering related, has a positive impact on performance and retention. If career-related, the work experience provides the student with a better understanding of how his academic preparation relates to his future career goals. Some students gain better insight into the different aspects of engineering through the work experience. Other benefits are that a student gains more maturity from working and that by earning a portion of his college expenses, he is more interested in getting his "money's worth" and will work more diligently to do well academically. Several schools reported that students who work generally take reduced course loads (and accumulate hours at a slower rate), but persist in engineering to a higher degree than students who do not work. No work experience should require more than 15 to 20 hours of a student's time. Working more than 20 hours a week will interfere with a student's academic performance.

In College Dropouts: A National Profile (ACE, 1972), Astin reports that students had less chance of staying in college if they were employed during the school year. In *Preventing Students from Dropping Out* (Josey-Bass, 1976), Astin reported that having a campus job during the freshman year strongly increases the students' chances of finishing college. Participation in federal work-study programs reduces drop-out rates, particularly for blacks. Also, reliance on loans is associated with increased persistence among black students attending white colleges. Working full-time, on the other hand, has a consistently negative effect on persistence. This may be because the work is a significant distraction from studies and social life.

In *Preventing Students From Dropping Out*, Astin explains why working part-time on campus may improve retention as follows:

> Several factors may account for this positive effect: economic- students with jobs are more financially secure to continue their studies; psychological- a regular job on campus means that the student will be spending more time on campus and interacting more with fellow students and staff. For many students, greater involvement in campus life and activities may help to develop a stronger sense of identification with the institution which serves as a deterrent to dropping out.

Astin makes another important point about part-time campus employment that may be important to minority students.

The effects of college employment are most beneficial among students who receive no grant or loan support or only minor support from these two sources of financial aid. For students with substantial financial need, packaging work programs with scholarship and loan support should be done with care.

The effects of student employment during the school year is an area that should be investigated in more depth with a specific focus on minority engineering students. Until that work is completed, caution should be exercised in assigning campus jobs to underprepared students, particularly freshmen. Engineering schools should review their policies relating to required work-study jobs and revise them where necessary to accommodate those students for whom working during the school year is detrimental to their academic success.

Co-op and Summer Jobs

While there appears to be some basic disagreements about the effect of part-time jobs on retention, almost all of the colleges report that co-op and summer jobs tend to impact in a positive way on retention. While working on co-op jobs students become more self-assured and enthusiastic about their studies. These jobs not only enhance motivation and increase the relevance of engineering education to a real-world, professional base, they can also provide a financial resource to underwrite the costs of an engineering education. Greater participation in co-op programs by minority students in worthwhile engineering jobs would probably lead to improved retention rates. Summer jobs can have the same effect, and engineering colleges should encourage and assist minority students to locate summer jobs, even as early as the freshman year.

Retention Program Models

ADMINISTRATION OF MINORITY PROGRAMS

The retention efforts for minority students at the engineering colleges are generally coordinated through a minority program within the colleges' administrative structures. Some of the colleges have clearly articulated, special programs with a program staff, while others have only informal programs with no special staff, but special attention is given to the minority students to ensure that they take full advantage of the services and support systems that already exist within the college or the university. Most of the schools have found that programs initiated and based in engineering colleges are more effective than university-based (campus-wide) services for minority students, because the engineering colleges are more aware of the specific demands on the engineering students.

At those schools with relatively structured programs, the chief administrator of the program is usually an assistant or associate dean, the dean of the college, or director of the minority program. The program is often located in the dean's office, the admissions office, or student services office. Few of the programs have been faculty initiated per se.

The sizes of the staffs vary from school to school. Twenty-one of the predominantly white engineering colleges reported having one or more staff persons assigned to the minority program. One private college reported having 10 full-time minority program staff members and two private schools reported 30. Several of the programs have student to staff ratios (full- or part-time director, counselors, coordinators, and other resource persons) as high as 150 to 1. Two of the private schools have a 10 to 1 student-to-staff ratio. Ten of the schools in the survey reported student-to-staff ratios of about 20-30 to 1. The approximate average ratio for the schools in our survey is 50 to 1.

The survey instrument contained a checklist that the schools used to report the principal duties and responsibilities of the minority program staff. The two items that received the greatest number of responses were personal and academic counseling (24) and recruiting (23). These were followed by general administrative duties (20), fund raising for the program (19), assisting students in finding summer jobs (19), and total or partial responsibility for deciding financial aid awards for minority students (17). Those remaining items included coordinating the tutoring program (16), representing minority student interests in faculty meetings (14), chief administrator for summer programs (12), advisor for minority student organization (13), and approve course selection of freshman and sophomore minority students (12). Several schools reported items that were not on the checklist. The minority program staff members at Carnegie-Mellon must each teach at least one course per year as a part of their staff responsibilities, and at Oklahoma State University the minority program administrator coordinates the minority program activities at his school with other schools in the state. For those colleges that are active participants in minority engineering consortia (e.g. PRIME, CIC+MPME, ECCM, etc.), members of the college staff have the additional responsibility of coordinating their colleges' activities with those in the organization.

Effective Programs

The most effective minority programs appear to be those that are broad-based, have good funding, and a strong authority base. The programs are many faceted and the components (e.g., recruiting, admissions, summer programs, financial aid, tutoring services, advising and counseling, summer/co-op job placement assistance, career guidance, minority student engineering organizations) are well coordinated and are constantly evolving. The continued quality and growth of the program is aided by the use of college and university financial resources that are supplemented with funds obtained from industrial corporations and foundations.

In addition to coordinating services and fund raising, the staff members at the successful programs also devote a portion of their time for planning and evaluation of the program. Staff members also make an effort to interact with the faculty in other parts of the college whenever possible to ensure that the program is perceived as an integral and necessary part of the college's normal business rather than as a separate and unrelated activity. The faculty has the ultimate power base within the college and the minority program benefits when the faculty endorses and participates in the program.

Equal in importance to the services provided through the program and the number of staff persons working with the program are the personal characteristics of the staff members. It appears that committed, hard-working, dynamic individuals who value the welfare of the students in the program as a high priority are essential to the development of a successful program, especially during its initial stages. The successful program director often serves as friend and confidant to the students, as well as one who pressures them on an individual and personal basis to work to the best of their abilities. These qualities may best be summed up by quoting one of the respondants to the survey instrument:

> Throughout this questionnaire I am somewhat disappointed that so many questions are directed at systems and services and programs, but very few at the amount of time and effort spent by people in doing these things. I believe that the success of a program depends more on who is involved in it and not so much what the program is. The best program in the world won't work if an uncommitted or incompetent runs it.

In order for the program staff to fulfill this important role, it must obtain the trust and confidence of the students. This is usually done by building a personal relationship with the students through numerous contacts and by making sincere efforts to find solutions to their individual or collective problems. In contacts with the students through recruiting activities, summer programs, counseling sessions, etc., the staff has the opportunity to develop rapport with the students and get to know them on a personal basis. The more time that is spent with the individual students, the less alienated the students will feel, if the school's environment is very different from that which they have previously experienced. Staff members can serve as spokesmen for students with faculty members, financial aid officers, or other university officials when the students themselves have not been able to establish effective communications with them. Program staff members who are knowledgeable about the resources and services throughout the campus can advise students where to go to help find solutions to any problems that they might encounter. This is particularly important for freshman and sophomore students.

Because motivation and self-confidence have been shown to be important factors in the retention of students in an engineering education, the minority programs at some of the colleges have activities designed to provide special recognition and rewards to successful minority students that can increase their motivation and self-confidence. At some schools the minority programs provide merit scholarships, recognition awards and/or banquets for those minority students that have outstanding academic achievements.

Improving Programs

As has been noted, one of the most important determinants in the success of a minority program is the staff. Many programs could be improved by adding more staff members or by changing one or two from part-time to full-time responsibilities for the program operation. As the minority student enrollments grow and the complexity of the programs increase, the staff should grow accordingly. If the minority student enrollment is multiethnic, the program staff should be multiethnic, or at least be sympathetic and responsive to all ethnic groups represented in the student body. Staff members that are not timid and, when appropriate, will question actions and policies that are not in the best interest of the students in the program can contribute to a more successful program. Because minority faculty members are so rare at the predominantly white engineering colleges, the minority program staff members may serve as role models of authority within the college.

The program director should strive to involve members of the faculty as often as possible in the decision-making function and operation of the program. Effective two-way communication between the program staff and the faculty is essential for a successful program. The more aware the faculty members are of the goals and objectives of the program and the more they have been involved in policy and planning, the more sensitive and responsive they will be to the minority students. The program director should regularly attend faculty meetings and the department meetings periodically. The program director is most effective when he can establish and maintain rapport with both the students in the program and the college faculty.

This parallels one conclusion by the Educational Testing Service of a Special Services Program evaluation (1975), which stated:

> Administrative acceptance and support and the ability of the program director to establish himself in the campus political and power system, appears basic. Successful accommodation and institutionalization of the disadvantaged involves regular faculty, staff, curriculum, as well as special efforts or support services.

The minority programs at some schools could be more effective if they received greater long-term commitment for funding. Long-range planning and fine tuning of the program have a permanent and stable status.

Minority Program Costs

Figures 3 and 4 show information collected from 24 engineering colleges on costs for their minority engineering programs. Costs include expenditures for recruiting, high school institutes, summer programs, tutoring, counseling, minority student organizations, career guidance and motivation programs, etc. Figure 3 reports the average cost per student and the range of costs per student for different enrollment sizes and institutional governance patterns. Figure 4 shows trends in recent minority program costs and extrapolations, using data reported by the schools, to a constant or level amount of expenditures for the minority programs.

The figures imply the following trends: the larger the school, the more is spent per student; the smaller the minority student enrollment, the larger the average program cost per student; and the private colleges have a higher average program cost per student than the public colleges. Assuming continued growth in enrollments and services, when the private colleges attain a steady-state situation in their minority programs, they will be spending an average of $224,000 for each program. The public schools will be spending an average of $86,000. The commitment and support of the institutions themselves and of outside funding agencies must continue if enrollment and graduation goals are to be met.

The previously cited U.S. Office of Education report on the effectiveness of Special Services programs also states that universities and colleges with Special Services supportive programs expended an average of $673 per FTE student per year. This amount excluded the cost of financial aid.

The essential elements for effective retention programs and their relative importance have already been described in some detail in this report. One can observe the effective interaction of these elements by looking at several programs that have been relatively successful. The structure of an effective retention program may vary from one school to another because of basic differences in the characters of the schools. In this section of the report, programs that have been successful in different institutional settings will be described.

The engineering colleges at Illinois Institute of Technology, New Mexico State University, the University of Kansas, and the University of

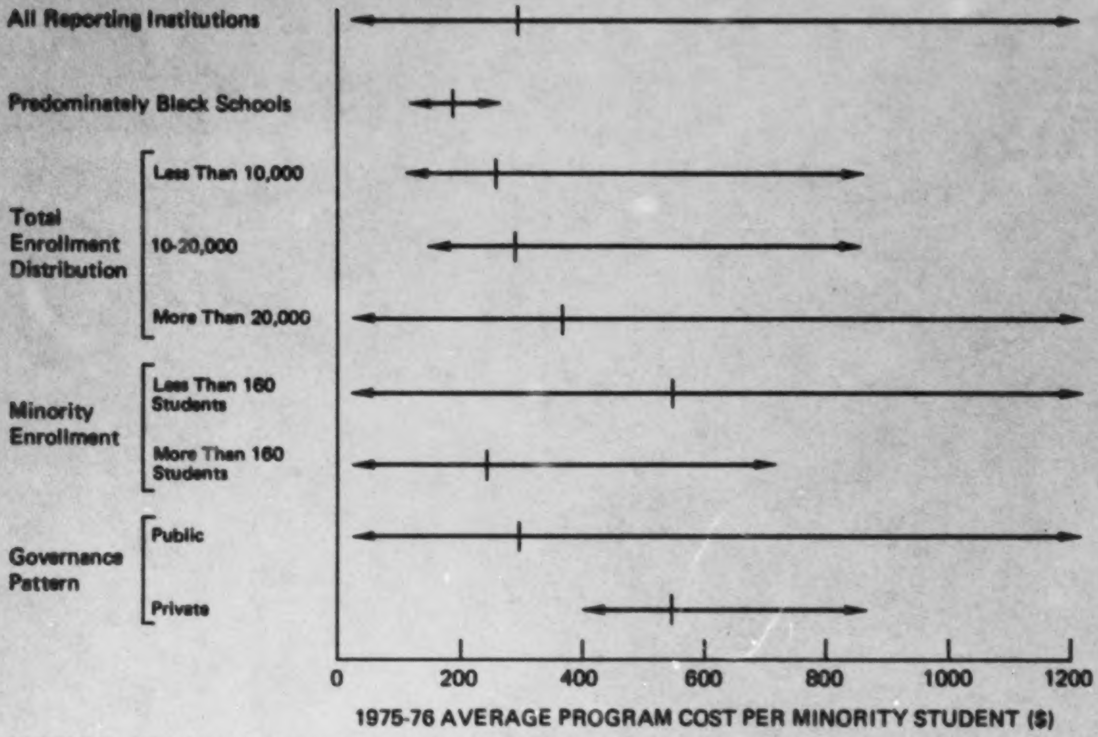


FIGURE 3 Minority engineering program cost per student.

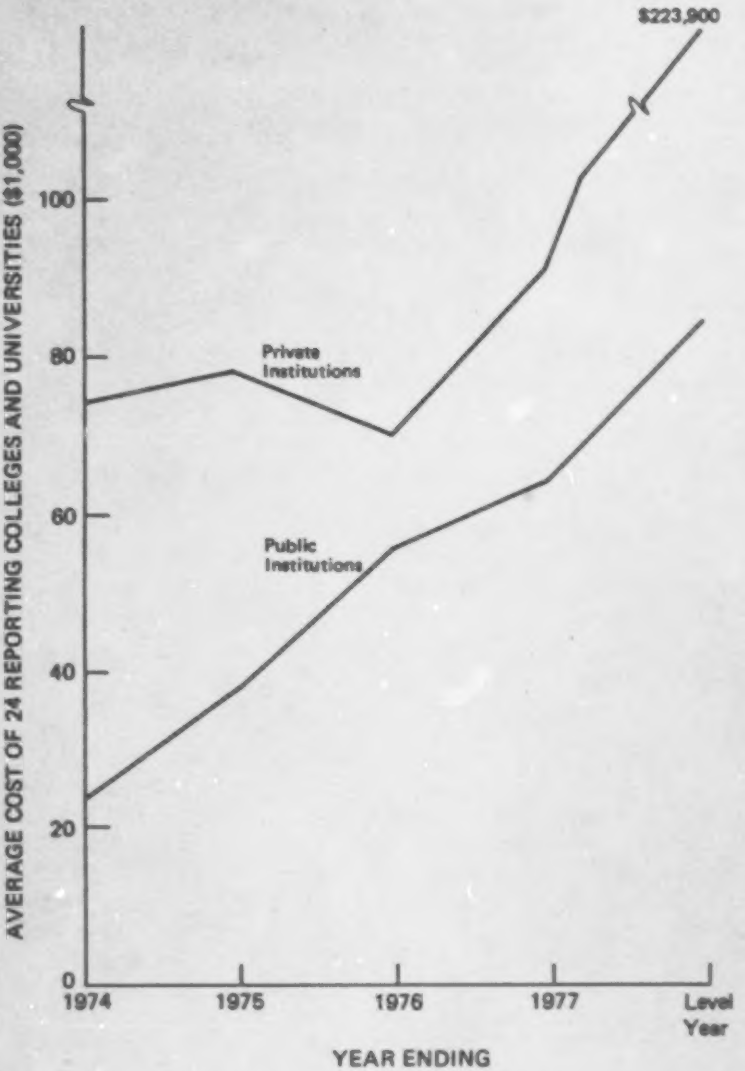


FIGURE 4 Average cost of minority engineering programs, public and private institutions.

Pennsylvania have developed relatively successful minority retention programs. These schools are examples of public and private institutions that documented relatively good minority student retention rates.

ILLINOIS INSTITUTE OF TECHNOLOGY (IIT)

IIT is a private university in Chicago, Illinois. In 1975-76 its total engineering enrollment of 905 included 126 minority students.

Of the minority students admitted to IIT in 1974, 97 percent were still enrolled in the spring of 1977. Most students who entered in 1974 were expected to graduate in 1977, and it is expected that the graduation rate will approximate the school's estimated retention rate. Before implementation of the retention program, the retention rate for minorities at IIT was approximately 55 percent. Another indication of the effectiveness of the program can be found by examining the number of students who were on academic probation or warning in 1974-75. During that year the average percentage of minority students in each class on academic warning or probation was 4 percent less than the average for all students in each class.

A major component of the IIT program is the Early Identification Program through which a number of minority juniors in the Chicago area high schools are identified who have the ability and possibly the interest to undertake an engineering education. On the Saturdays of the spring term of the junior year, the summer following the junior year, and Saturdays or on afternoons after school in the senior year, the students in the program take math and science courses at IIT or a local junior college to supplement their regular course work at the students' high schools and satisfy all prerequisites for admission. They are also introduced to engineering activities including plant visits. In the summer preceeding their matriculation to college, the students work in co-op jobs with local Chicago industrial companies. The students can go back to work for those companies every summer for as long as they stay in school. By the time the students matriculate to the college of their choice (most, but not all attend IIT), there is very little, if any, need for compensatory course work. Because of the quality of the students selected for participation in the program and the extensive amount of extra academic work obtained while still in high school, the minority students who enter IIT do not have as many of the severe academic handicaps that often lead to attrition. The standardized test scores of the freshman minority students are roughly comparable to those of the entire freshman class. The minority students rank in the top quarter of their high school classes, and the class rank for all freshman students is in the top half.

In addition to the academic preparation, another very important aspect of the IIT program is the extremely close personal involvement of the minority staff members and other school officials with the minority students over the one and a half years prior to enrollment at the school. Also, knowing the campus and some of the school officials minimizes some of the traumatic experiences that many students encounter in the transition to higher education from high school. The personal contact that is developed with the students in the precollege portion of the program is continued as they move through the program in the ensuing years. This frequent and informal contact on the campus enables the program staff to follow the students' academic progress. Potential problems can be identified and addressed before they get out of hand.

The Black Students' Organization (BSO) plays an important role at IIT. The organization keeps a set of old exams and uses them to assist the freshman students. Each BSO member counsels three lower classmen and this enhances the students' sense of belonging to the campus family.

The success of the program at IT derives in part from the overall atmosphere surrounding the program and its students. It is a positive atmosphere that is achievement oriented; it is an environment that is conducive to success. The students do not expect that they will not do well. They do not perceive that the school expects them to not do well. The optimism, enthusiasm, and energy of the program director is a primary reason that such an environment exists at IIT. The strong commitment and active support of the dean and the college also contribute to this favorable academic atmosphere surrounding the program.

IIT is able to conduct its retention program because of its location. In the large urban city of Chicago there are enough minority students in the secondary school system that a sufficient number of them with the potential for engineering can be found. There are also a large number of companies that can provide the summer job experiences which are a major part of the program.

NEW MEXICO STATE

New Mexico State University is located in Las Cruces, New Mexico, which has a relatively large minority population. The university and college of engineering have a long history of being knowledgeable and receptive to the problems of the minority students they serve and have employed admissions policies and curriculum features that serve the needs of all students. In 1975-76, 2,751 of the 10,649 students enrolled at the university were minorities; further, in the college of engineering there were 300 ethnic minorities in a total undergraduate enrollment of 1,226.

The school has designed a retention program for all its students and the minority students are free to use the services. The College Opportunity Program Enrichment (COPE) is a university-wide program for the purpose of assisting students with low ACT scores or weak high school backgrounds to cope with their problems and complete their academic programs. Through COPE special one-semester courses are provided which are preparatory for entering into "regular" college-level course work. Many of the minority students who come to the university are products of relatively small, rural high schools and have not had the opportunity of taking many of the courses which are presumed necessary for college-level work. Another component, Special Student Services, utilizes a well-organized peer counseling and tutoring arrangement for students in need of special help. Each department in the engineering college also sponsors a peer tutoring program through its student society organization. The university has also established ethnic offices that address the specific needs of the minority students. There are three such offices—one for Chicanos, one for blacks, and one for American Indians.

The college of engineering has several activities that are specifically for minority students that impact upon retention. The college has a MITE program and a Designated Academic Opportunity Scholarship Program (DAOS). The orientation aspects of the MITE program are intended to instill in the students the concept that they can compete on an equal basis with the nonminority students. The motivational aspects of the MITE program also help to inspire the participants and increase their commitment to engineering. The DAOS is a supplemental scholarship program for women and minority students. The scholarships are for the freshman year only. Resources for the program are provided by industrial companies. The companies that participate in the program also make a commitment to provide a summer job for each scholarship it provides. The scholarships are equivalent to one year's tuition at New Mexico State. The availability of the Cooperative Education Program allows students the work and/or financial assistance that is necessary to complete their studies after the freshman year. DAOS can serve as a feeder to the co-op program. Special advisors are assigned to each DOAS student to assist them in the selection of their courses and to carefully monitor their progress during their first two semesters. The faculty members can contribute considerable motivation and stimulation to the students.

The minority students at New Mexico State participate in the college's co-op program to a relatively large degree. In 1976, about 35 percent of the co-op students were minority students. Their participation in co-op has had a significant effect in aiding them to complete their engineering education. The program not only aides the further education, motivation, and development of students, but it also provides financial assistance to off-set educational costs.

For the Spanish-surnamed student, the geographical location of the school is such that the student is in a population mix that is approximately 50 percent Spanish. Thus, he or she is very much at home, which is a distinct advantage in that he is with a peer group which is almost a "nonminority" environment.

UNIVERSITY OF KANSAS

The University of Kansas is a public university located in Lawrence, Kansas. In 1975-76 its total engineering enrollment of 1,200 undergraduate students contained 55 minority students. Ninety percent of the minority students admitted to the University of Kansas in 1973 were still enrolled in the spring of 1976.

This retention rate was obtained in a public university with an open admissions policy. Of the six students who were in the program in its beginning in 1969, all have gone on to obtain engineering degrees. Because of their current status in the junior class, it is expected that 95 percent of the students who entered in 1973 will complete their education at the University of Kansas. The retention rates have dropped on a yearly basis to approach 85 percent for the Student Council for Recruiting, Motivating and Educating Black Engineers (SCoRMEBE) program.

One of the major components in the SCoRMEBE program is its summer program, which lasts for eight and one-half weeks. Because of its open admissions policy, the University of Kansas has instituted within its summer program reading and study skills courses and academic courses in physical science and mathematics. The students who participated in this program have not on the average experienced failure within the School of Engineering because of the dedication shown by the professors who have provided free time to teach the courses, along with the types of courses and the manner in which they are presented.

Another very important motivational part of the SCoRMEBE program for the students has been their visits to industry, and the solicitation of funds and students for the program.

The students who entered the SCoRMEBE program, in some cases, have demonstrated some of the deficiencies outlined in this report; however, by using the summer program and with some curriculum flexibility in the first year, these students have pursued their engineering degree and achieved success through graduation. The program has graduated a student with an ACT score of 14, as well as students with ACT scores in excess of 25. To accomplish this, the SCoRMEBE program has implemented a very strong supportive service program.

The supportive educational program includes tutorial services, counseling and advising done by faculty and staff with program advisers, and visitations to high schools for the participating students to speak to potential students.

Along with these services, there is a study hall, one senior student who is assigned to track special problem students, and a buddy system implemented where one student is assigned to a group of students and they meet throughout the week to determine if they are encountering academic difficulty. The students are also required to write a schedule describing how they spend their time throughout the academic year.

The close relationship of students and staff and the student involvement in the administrative aspects of SCoRMEBE have caused this program to be evaluated by the Kansas State University community as the most successful student program on campus.

Students, along with faculty and staff, are raising an endowment that will help perpetuate the program in terms of scholarships and grants. This strong faculty commitment is also evident in the time they donate to the summer program along with the academic year in tutoring the in-class and out-of-class instruction period. Out-of-class instruction used by the SCoRMEBE program has been very successful. The strong commitment to the program by Kansas State administrators and the administrators of the school of engineering is in part responsible for the success of this program.

The SCoRMEBE program holds a symposium once a year that attracts industry and high school students from many areas. There are workshops throughout the symposium to address the various problems that have been outlined within this report. The students are expected to have a summer job, and those earnings are in fact applied toward the cost of their education.

UNIVERSITY OF PENNSYLVANIA

For 1975-76 the minority enrollment of 56 comprised approximately 10 percent of the total enrollment of 532 students. For the freshman class that entered in 1975, 80 percent of the minority students were in the top quarter of their high school classes and 86 percent of the entire freshman class were in the top quarter of their high school classes. The math SAT scores of the minority freshmen averaged more than 100 points less than the class as a whole. The average retention rate for minority students in the college of engineering over the past five years is roughly equivalent to that of the nonminority students. All of the minority students that registered in fall 1974 as freshmen returned to the college for the sophomore year.

At Penn there are no special remedial courses, but with careful advising, freshmen can stretch out the first year or stretch the first semester courses throughout the entire freshman year. The college also provides "reteaching sessions" or repeats of information during afternoons and evenings, which are open to all students. The college has developed a four-and-one-half-year plan that allows students to spread their course work in a structured manner. As a part of the total program, there are self-paced instruction opportunities available to all students.

In addition to the advising and counseling provided by the faculty advisors and the part-time minority staff person, informal but effective advising, counseling, and tutoring is provided by minority upperclassmen and graduate students. Faculty members and fraternities and honor societies also tutor students who seek their help. The engineering administrators and individual faculty members are committed to the school's efforts for minority students, and this has been instrumental to the school's success. The student organization, Black Engineering Society, has generally had a positive effect on the academic performances of the minority students because it contributes to a sense of belonging for them. It is from this group that they derive peer support.

Penn's involvement in the Philadelphia Regional Introduction for Minorities to Engineering (PRIME) is beginning to provide a regional network for solving some of the retention problems for minority students. Through PRIME, the University of Pennsylvania and other Philadelphia engineering colleges identify potential engineering students at the eighth-grade level, provide both academic year and summer math and communications skills enhancement programs for them through graduation, obtain scholarship and funding information for minority programs, and provide exposure for parents and community groups to opportunities in engineering-based careers so that parents can be more supportive of their children who are interested in pursuing engineering. PRIME serves as a vehicle through which the participating schools seek resources from industries and foundations for the support of their various minority programs. PRIME is also important to the retention efforts of the participating colleges because through a school's active support and participation in PRIME, a smoothly operated and coordinated regional mechanism is available for high school students to receive the proper preparatory course work, guidance, and motivation that are basic to an effective retention effort.

The commitment to minority engineering education at Penn by the administration and faculty is a vital key to its success.

Future Studies

It is clear by now that additional research should be conducted into the causes of failures and dropouts among minority students and that more reliable information needs to be gathered on the retention of all students in engineering schools. The Task Force recognizes, however, that few engineering schools have the means either to measure and document the retention rates of minority students and the rest of the student population or to evaluate the effectiveness of any program to reduce the number of dropouts. Worse yet, as all institutions of higher education are likely to experience greater operating costs, brought about by monetary inflation and higher salaries, studies of the type recommended here may be considered of marginal priority. The Task Force considers the proposed studies to be important because, (1) better understanding of all the factors that affect retention will be useful in developing programs and strategies for increasing the participation of minorities in engineering, and (2) improved retention rates will contribute to stabilizing student populations and possibly reducing the costs of remedial courses, administrative procedures, and other activities so prevalent today to meet special needs of underprepared, undermotivated, and underfinanced students in higher education.

Therefore, the Task Force lists the following areas for study:

Nationwide Studies

1 *Longitudinal Study of Retention Rates.* A comprehensive national study to determine the retention rates of minority students, as well as all engineering students, would document the differences that are necessary to understand in making policy and funding decisions, evaluations of educational programs, manpower projections, as well as providing

guidance information for counselors in the secondary and postsecondary educational institutions.

This might be undertaken cooperatively by one of the professional engineering societies and, perhaps, a national educational research organization. Because the Engineer's Council for Professional Development (ECPD) has a continuing relationship with all engineering schools seeking to obtain or maintain ECPD accreditation, the instruments used in the accreditation process could be modified to gather data for this study. In its accreditation procedure, ECPD already collects student enrollment data, and data on retention rates could be collected in addition. Such other national organizations as the American Society for Engineering Education and the Engineering Manpower Commission also interact with engineering colleges and could gather data on retention rates throughout the country.

The study should take into account that retention rates are never static. Hence, while the study would determine the actual rates, it would also provide a dynamic projection of retention rates.

2 *Comparison of Retention Rates for Minority Engineering Students with Other Minority Students.* Educators, engineering groups, and government policymakers will find useful a careful assessment of the differences in personal profiles of the minority students who seek to become engineers and those who enter law school, say, or study biochemistry. How do the various minority students differ if at all? Among which students are the factors leading to failure or dropout likely to appear? What lessons can be learned from such data?

3 *Identification of the Causal Factors Associated with Minority Engineering Student Attrition.* Because the Task Force's study is only a first step in identifying the causal factors associated with retention, a more comprehensive national longitudinal study is considered necessary to develop and assess supportive service programs that would be useful to secondary school counselors of minority students as well as to all students interested in engineering. Once the factors leading to better retention have been identified and verified by such a study, concerned individuals and organizations would be able to develop a list of goals and projects, in order of priority, to help achieve increases in the number of minority engineering graduates.

4 *Assessment of Supportive Programs.* Little data or other evidence exists that document the elements of the support programs to advance the retention of minority students. One possible study could compare a student control population that receives no support services and a student group of comparable socioeconomic backgrounds and abilities that does receive such services. But a study of this type, however, is neither

morally nor ethically acceptable. An alternative to this is an examination of the effect of support services, followed over a four to five year period at a number of schools and compared to a four or five year period when such services did not exist or at another similar group of schools during the same period at which the services are not provided. Although it would be difficult to design a quantitative analysis for such a study, evaluations like this are necessary so that more successful programs can be continued or expanded, less successful programs can be modified. Important background information for such research would be the results of the earlier proposed study on the causes of attrition for minority students, as well as current data and trends on student academic profiles, career aspirations, financial status, and other factors for minority students. All the cognitive and noncognitive factors associated with the learning process should be taken into account.

5 *Evaluation of Precollege Programs.* Precollege programs take a variety of forms, such as transition programs that bridge the senior year in secondary education with the freshman year in higher education, cooperative programs among businesses, colleges, universities, and the high schools that are designed to provide students with a stimulus to enter engineering, and other innovative approaches such as technical high schools and/or magnet schools that (like the Bronx High School of Science in New York City) prepare students specifically for advanced studies in physical sciences, say, or engineering. While such programs have merit, just how much merit is a subject of debate among educators and psychologists. Accordingly, the Task Force suggests that studies should be undertaken to evaluate the various programs, their effects, taking into account the type of students who emerge into accredited engineering schools, the types of engineers they produce, and, what is more, their relation to the goal of increasing the number of minority engineering graduates.

Institutionally Based Studies

1 *Institutional Retention Rates.* The Task Force strongly encourages each engineering college to begin to document the retention rates for minority students and attempt to determine the causes of attrition among minority students. Each institution should attempt to identify the attributes that characterize it as unique in terms of attracting students, retaining students, and motivating students. Such information is necessary before it can be gathered, collated, and analyzed into a national study of retention for minority students in engineering. While the major generic causes of minority student attrition can be determined in a

national study, the factors may or may not apply to individual institutions with special problems and students.

2 *Minority Student Participation*. Much has been written about why the minority students do not enter the mainstream of student activities on campuses at predominantly white institutions. Because of differences in student profiles at each campus, as well as differences in admissions criteria, financial aid policies, and faculty and staff policies, each institution needs to examine carefully its own situation to determine how institutional policies affect minority student participation in major campus activities.

3 *Funding Commitment*. Studies of the funding support that can be provided at each engineering school now and in the future, as well as those that are feasible at a time of budgetary crisis, are necessary to permit the institution to plan properly for the future.

REFERENCES

Astin, Alexander W. (1972) *College Dropouts: A National Profile*. ACE Research Reports, Vol. 7, No. 1., Washington, D. C.: American Council on Education.

Astin, Alexander W. (1975) *Dropouts, Stopouts, and Persisters: A National Profile*. Laboratory for Research and Higher Education. Los Angeles: University of California.

Astin, Alexander W. (1971) *Predicting Academic Performance in College*. New York: Free Press.

Astin, H. S. (1970) *Educational Progress of Disadvantaged Students*. Washington, D. C.: Bureau of Social Science Research, Inc.

Bayer, Alan E. (1972) *The Black College Freshman: Characteristics and Recent Trends*. ACE Research Reports. Washington, D. C.: American Council on Education.

Becker, Heather and Mowsesian, Richard (1976) Examining engineering students by sex and ethnic background. *Engineering Education* 67: 162-166.

Bond, Arthur J., LeBold, William K., and Thomas, Majorie (1977) *Recruitment and Retention of Black Americans in Engineering at Purdue*. Lafayette, Indiana: Purdue University Press.

Borders-Patterson, Anne, Burkeheimer, Graham, Davis, and Junius, A. (1975) *The Impact of Special Services Programs in Higher Education for "Disadvantaged" Students*. Princeton, New Jersey: Educational Testing Service.

Cleary, T. A. (1968) Test bias: prediction of grades of negro and white students in integrated colleges. *Journal of Educational Measurement* 5: 115-124.

Di Cesare, A. C., Sedlacek, W. E., and Brooks, G. C., Jr. (1972) Nonintellectual correlates of black student attrition. *The Journal of College Student Personnel* 13: 319-324.

Foster, Robert J. (1975) *Differences between persisters and nonpersisters in engineering programs*. Presentation at the Annual Conference of American Society for Engineering Education, Fort Collins, Colorado.

Foster, Robert J. (1974) They who start in engineering. *Engineering Design Graphics Journal* 38: 33-36.

Goldman, R. D., and Hewitt, B. N. (1974) An investigation of test bias for Mexican American college students. *Journal of Educational Measurement* 12(3): 187-196.

Gordon, Edmund W. (1975) *Opportunity Programs for the Disadvantaged in Higher Education.* National Institute of Education (DHEW), Report No. RR-6, 1975. Washington, D. C.: Department of Health, Education and Welfare.

Institute for the Study of Educational Policy (1976) *Equal Educational Opportunity for Blacks in U.S. Higher Educational Policy.* Washington, D.C.: Howard University Press.

Kaufman, Harold (1977) Black engineering students—why the poor retention rate? *New Engineer,* Vol. 6, No. 1, 33-37.

Landis, Ray (1976) Improving the retention of minority engineering students. *Engineering Education* 66:(7) 737-739.

Mack, R. F. P. (1973) Predicting college persistence for educational opportunity students. *Psychology* 10: 14-24.

Miller, A. J. and Twyman, J. P. (1967) Persistence in engineering and technical institute programs: A study of some nonintellective concomitants. *The Journal of Human Resources* 2: 254-262.

Morgan, L. B. (1975) Improving the retention of engineering students. *Engineering Education* 65: 166-170.

National Science Foundation (1977) *Women and Minorities in Science and Engineering.* Washington, D. C.: National Science Foundation.

Nieves, Luis, B. (1976) *The Minority College Student Experience; A Review of the Literature.* Unpublished paper, Educational Testing Service, Office of Minority Education, Princeton, New Jersey.

Stanley, J. C. and Porter, A. C. (1967) Correlation of scholastic aptitude test scores with college grades for negros vs. whites. *Journal of Educational Measurement* 4: 199-218.

Stanley, J. C. (1967) Predicting college success of the educationally disadvantaged. *Science* 171: 640-657.

Temp, G. (1971) Validity of the SAT for blacks and whites in thirteen integrated institutions. *Journal of Educational Measurements* 8: 245-251.

The Alfred P. Sloan Foundation (1974) *Minorities in Engineering—A Blueprint for Action.* A Report of the Planning Commission for Expanding Minority Opportunities in Engineering. New York: The Alfred P. Sloan Foundation.

Tinto, Vincent and Sherman, Roger H. (1974) *The Effectiveness of Secondary and Higher Education Intervention Programs: A Critical Review of the Research.* New York: Columbia University.

Trapp, D., Pailthrop, K., and Cope, R. (1971) Entrance characteristics and their relationship to types of student dropouts. In *institutional research and institutional policy formulation.* 11th Annual Forum of the Association for Institutional Research 1971. Claremont, California: Office of Institutional Research.

Appendix A

SURVEY OF MINORITY ENGINEERING RETENTION PROGRAMS

1. Please indicate the percentage of those students who entered in the years shown below who have graduated or are currently enrolled in your college. We would like the information to be as accurate as possible, but if necessary, estimates are acceptable. Please do not include transfer students in data reported. If any estimates are used, please indicate as such.

		Graduated or Enrolled in Fall 1975			
Year Entered (class of)		All Students		Minority Students	
		%	No.	%	No.
1970	('74)				
1971	('75)				
1972	('76)				
1973	('77)				
1974	('78)				

* Minority students for this study include those of American Indian, Puerto Rican, Mexican-American (Chicano), and Black ethnic backgrounds.

2. What primary causative factors do you feel are responsible for the magnitude of the retention rates which you show for all engineering students?

3. What primary causative factors do you feel are responsible for the magnitude of the retention rates which you show for minority engineering students?

4. What are your retention program components for all students in engineering?

5. What special retention program components in addition to the normal retention program for all students do you have for minority engineering students?

6. From your response in Question 5, which of the program components do you feel are most or least effective in the area of retention for all engineering students?

7. From your responses in Questions 5 and 6, which of the program components do you feel are most or least effective in the area of retention for minority students?

If you have an existing retention study for your program or other data supporting the retention program, we would appreciate receiving it. Would you also be amenable to us visiting with you concerning the minority engineering program and all supporting data?

Appendix B

QUESTIONNAIRE B

STUDY OF PROGRAMS FOR THE RETENTION OF MINORITY STUDENTS IN ENGINEERING EDUCATION

Committee on Minorities in Engineering

School: Date:
Contact person:
Title:

Total 1975-76 engineering enrollment
Total women enrollment
Total minority engineering enrollment
  Native american enrollment
  Puerto-Rican enrollment
  Mexican American enrollment
  Black enrollment

Type of institutional support (Public or Private)
Total annual cost of attending college

No reference will be made by name to any school participating in the study in the final report without the review and consent of the appropriate school official prior to release of the report.

*** For this study minority is defined as the Native American, Puerto Rican, Mexican American and Black ethnic groups.**

N/A = No answer or Not Applicable

Retention

1. **What percentage of engineering students for the academic year 1974-75 left the school of engineering and transferred from:**

   A. Engineering to another discipline:

   Minority: *6.2% (21 schools)* **All students:** *7.6% (14 schools)*
   12 N/A *19 N/A*

   B. To what disciplines did the students transfer?

   C. The University to another university:

   Minority: *3% (16 schools)* **All students:** *3.1% (9 schools)*
   17 N/A *24 N/A*

   D. Dropped out of the university:

   Minority: *12.0% (23 schools)* **All students:** *9.1% (14 schools)*
   11 N/A *19 N/A*

2. **For the following, please provide data:**

   A. What percentage of students during 1970-1974 left your college temporarily because of academic suspension or probation?

   Minority: *10.4% (16 schools)* **All students:** *7.6% (13 schools)*
   17 N/A *20 N/A*

   B. Of the percentage who left, what percentage of those have returned?

   Minority: *40.8% (15 schools)* **All students:** *22.9% (8 schools)*
   18 N/A *25 N/A*

   C. Of those that return, in general how do they fare compared to those students who did not leave? (If there are differences for the majority and minority students please indicate).

3. **What is the average number of terms/semesters that are required for your students to complete the degree requirements:**

   Minority: *10.5 (28 schools)* **All students:** *9.95 (28 schools)*

4. **A. Have you observed that financial aid worries adversely affect the academic performances of a significant portion of the minority students at your college?** *Yes—20, No—12* *No answer—1*

   B. How does this compare with the majority students?

   C. What percentage of minority students in good academic standing left because of inadequate financial aid during your last two years?
   2.9% (21 schools; 13 of them reported 0%)—12 N/A

5. A. What are the reasons provided by minority students and your views on why students drop out of your engineering program?

   Poor academic performance. Uncertain about career objectives. Personal and family problems. Financial problems. Financial worries. Probation. Lack of preparation. Inability to perform adequately in mathematics and physics courses. The actual reasons are as varied as the students. Those with inadequate preparation are unwilling to devote the time and effort required to make up the deficiency. Change of career goals. Lack of aptitude. Ill prepared for social and academic climate of a large, primarily white university. Poor career counseling in high school. Inadequate preparation in communication skills. Lack of understanding of what engineering is. Transportation.

   B. Which reasons are the most common?

   Poor academic performance. Lack of interest. Lack of financial resources. Inadequate preparation. Poor definition of academic goals. Lack of understanding of what engineering is. Poor high schools. Study habits. Adjusting to University environment. Change of career plans. Personal problems.

6. In your opinion, does the particular geographical location of your school present any advantages or disadvantages that affect retention of the following groups of minority students enrolled at your college?

   A. Native American

   B. Spanish speaking/Spanish surname

   C. Black

   If yes to any of the above, please explain:

   No advantages or disadvantages. Advantage: middle of industrial community where jobs are available—tremendous motivational impact. Advantage: majority of population in this city is Mexican-American which makes transition to campus life easier. Think that campus atmosphere is more important than geographical location—campus atmosphere can lure students into unrealistic, dangerous attitude of complacency. Advantage: School is centrally located in city area where transportation is readily available. The idea of going to a school in a big city appeals to many students. Disadvantage: Temptation to fall back into their social groups off campus can be a detriment to good study habits. Most of the students come from an all black H. S. environment and the University is located in a conservative town with low interaction with the black community—This causes the student to return home at the slightest disappointment.

7. If you have observed that there are any characteristic aspects of the social or cultural backgrounds of the minority students at your college that tend to positively or negatively affect their retention in your college, please describe them below:

Minority students from professional families tend to perform better. None noticed—they are typical students who study throughout the week and party on the weekends. The bicultural background of the region and the college provides a common base for all students in engineering. Lack of role models (i.e. Family, relatives, friends who are engineers). Black students tend to segregate themselves and do not enter the mainstream of College or University experience. Most minority students are not prepared to "play the games" that are necessary to achieve in a primarily white, middle-class institution. Positive: Parents support and interest, concern not to disappoint parents and other family members—Negative: Low expectations from teachers and counselors in H.S.; class attendance; fear of, and discouragement of minority students with regard to math and science. Negative aspect—Tight family ties and financial pressures.

8. Of all the factors that might impact upon the retention of minority students in your college of engineering, would you please indicate below your opinion of their order of importance in their effect on the retention rate:

   A. Admissions criteria
   B. Math preparation prior to matriculation
   C. Science preparation prior to matriculation
   D. Motivation toward engineering
   E. Rigidity/flexibility of curriculum
   F. Availability and quality of tutoring
   G. Availability and quantity of counseling
   H. Existence of student organizations
   I. Social/economic background of students
   J. School setting (rural vs urban)
   K. Faculty attitude toward minority students
   L. Attitude of majority students toward minority students
   M. Personal/family problems
   N. Availability of adequate financial resources/aid
   O. Self-confidence of students to do the work
   P. Availability of summer/permanent jobs in engineering
   Q. Attitude of minority students toward majority students and faculty
   R. Existence of minority faculty members
   S. Academic performance
   T. Change in career goals
   U. Other

Admissions and Retention

9. How does your college recruit minority students? (Please check)

   A. No special program: same procedure for all students

B. High school visits by minority faculty/staff

C. Recruitment by currently enrolled minority students

D. Send letters to students from ME³ list (Minority Engineering Education Effort)

E. Send letters to students from CEEB (College Entrance Examination Board) student search list

F. Send letters to students from ACT (American College Test) list

G. Send letters to students from National Achievement Scholarship list

H. Recruit those students who have participated in precollege programs (e.g., Mite, Saturday Morning Programs, etc.)

I. Minority program staff members make personal contact through high school visits or telephone calls

J. Special program to bring minority admission candidates to the campus sometime during their senior year

K. Other (Specify)

L. Other

10. If you know why most of the minority engineering students selected your college, please explain below.

Geographically convenient. Financially possible. Financial aid programs are provided to take care of needy students. Traditionally black schools are better equipped to take care of special educational/cultural needs of black students. Good image of University in the state. Prestige attached to graduation from this university and the reputation and quality of engineering education obtained here. Location: 80% of our minority students are from this city. Lower cost of education. Variety of programs offered. Special program for minority students.

11. For the class that entered your college in fall 1975, please indicate the following:

A. Average Math ACT/SAT score: Minority All students

B. Average high school rank in class: Minority All students

Data summation for questions 11A, 11B

11A. Data Summation: SAT & ACT math scores

Total *range* for minority students for SAT:
419-579 for an n size of 9

Total *range* for all students for SAT:
512-668 for n = 11

Total *range* for minority students for ACT:
18-21 for n = 4

Total *range* for all students for ACT:
20-27 for n = 5

Averages
Public Schools:

Minority

SAT 467	*ACT 19.7*
(n = 3)	*(n = 4)*

All

SAT 576	*ACT 24.6*
(n = 4)	*(n = 5)*

Private Schools:

Minority

SAT 539	*ACT (n = 0)*
(n = 6)	

All

SAT 615	*ACT (n = 0)*
(n = 6)	

Black Schools:

Only one school responded, SAT 460 for all

Total Averages:
(with Black school
excluded)

Minority

SAT	ACT
516	*19.7*
n = 9	*n = 4*

All

SAT	ACT
599	*24.6*
n = 10	*n = 5*

11B. Data Summation: High School Rank (% of 100)

Public Schools:	Minority	All
	78%	*86%*
	n = 6	*n = 4*
Private Schools:	Minority	All
	87%	*85%*
	n = 4	*n = 4*
Black Schools:	Minority	All
	79%	*no response*
	n = 2	

Note: When an institution responded by brackets (e.g. upper ¼, etc.) the average of the particular bracket was used.

12. If you have found that standardized test scores are valid or invalid in predicting the educational progress of minority students in your college, please explain the evidence below.

They are invalid. Many more variables must be scrutinized. They are helpful, but must be supplemented with interviews in which prospective students can sell themselves via this non-quantitative factor. Both valid and invalid—they are valid with respect to the particular school plus an adjustment for family income. Not enough data available. Data for all engineering students since 1972 show that entrance test scores are valid predictors. Scores are valid indicators provided the student is not placed in direct competition with all high achievers and the same academic load during the first semester.

Data Summation:

Valid	Maybe Valid	Invalid	Not Applicable
11	*11*	*6*	*4*

(gave many reasons in narrative)

13. If you have found that other predictors (e.g. high school rank in class, personal interviews, etc.) are of greater value than standardized test scores in predicting the academic progress of minority students at your college, please list them below. Please include the *evidence* you have which demonstrates your success with these predictors.

Success in precollege special programs (MAP, MITE, Match programs). Personal interviews. Personal contact over an extended period of time. Students willingness to earn some of his own money. High school rank in class. Math grades in high school. Personal motivation. High school attended. Autobiography.

Data Summation:

High School Rank: 8
High School Grades: 5
High School Physics Grades: 4
High School Chemistry Grades: 4
Personal Characteristics, including Those Projected in Interviews: 6
Recommendations: 3
Success in pre-freshman (summer) programs: 2
Success in MITE-type programs: 2
Willingness to earn money: 1

14. What types of changes, if any, would you like to see adopted in the admissions policy for your college which would impact in a positive way upon the retention rate of your minority students?

No changes (24 schools). It is a well refined method at present. Admissions policy does not make a difference, unless an exceptional supportive service program is in effect. More recruitment of out-of-state students. Minority students should and do have to meet the same admissions and retention criteria as all other students. The coordination of financial aid and admissions with a high school person responsible for this area alone.

15. A. If you have a prefreshman summer program for minority students who have been admitted to your college, which of the items listed below are included in that program?

1)	No summer program	*13 schools*
2)	English course (written and verbal communication)	*7 schools*
3)	Calculus	*7 schools*
4)	Computer programming	*6 schools*
5)	Use of slide rule/calculators	*4 schools*
6)	Study skills building	*8 schools*
7)	Seminars by industrial representatives	*8 schools*
8)	Orientation to campus life, campus services and resource people, financial aid process (please circle appropriate item)	*13 schools*
9)	Orientation to engineering	*14 schools*
10)	Enrolled students serving as counselors/advisors/tutors	*14 schools*
11)	Other (specify) *Algebra/Trigonometry, Drafting*	
12)	Other *Work Experience, Diagnostic Tests*	

B. In your opinion, which of the above items has had the greatest impact upon improving the chances of the students' remaining in your college/improving their academic performances through the freshman year?

English Course—1 school
Calculus—3 schools
Study Skills Building—2 schools
Seminars by Indust. Reps—1 school
Orientation to Campus Life—4 schools
Orientation to Engineering—1 school
Enrolled Students as Counselors—2 schools
Algebra/Trigonometry—1 school
Remedial courses—1 school
Diagnostic Tests—1 school
All Combined—1 school

C. How long is the prefreshman summer program?

1) Two weeks or less *8 colleges*
2) Four weeks or less *3 colleges*
3) Six weeks or less *3 colleges*
4) Eight weeks or less *3 colleges*
5) More than eight weeks *3 colleges*

D. Is college credit given for courses completed in the summer program?

E. What changes, if any, would you like there to be made in the summer program which would impact upon the retention of the program attendees in your college?

Better selection process. Improved testing techniques. Longer duration of summer program. Would like to have a strong component in both summer program and academic year to work with students on study habits. More verbal and math work. Psychological adjustment counseling. More diagnostic testing. Refinement of career orientation. More participation by minority professionals. Expand to include more students. Provide financial assistance so that the students could take one regular university course for credit.

RETENTION AND TRANSFER STUDENTS

16. In the last two years, what proportion of minority students who enrolled as new students in your college attended junior/community colleges? *13.9% (24 schools)*
    9 N/A

17. A. How have minority transfer students fared in comparison to minority students enrolled in your school as freshmen?

    1. Much better *5 Schools*
    2. Much worse *4 Schools*
    3. About the same *15 Schools*
    N/A *9 Schools*

    B. If there is a difference, please explain:

RETENTION AND CURRICULUM FEATURES

18. What mechanisms do you use to enroll (place) minority students in different course levels in their first semester?

    Placement exams. ACT scores. Courses taken in H.S. Summer program's testing and diagnostics. H.S. grades. SAT scores. Individual counseling. Consultation with faculty advisor. Type of H.S.

    Data Summation:

    Placement Exams: Math 8, Chemistry 5, Physics 1
    High School Math Grades: 4
    Math ACT or SAT Scores: 9
    English Reading Test: 4
    Other Diagnostic Tests: 3
    Interview Sessions and Counseling: 9
    Results of Summer Pre-College Programs: 4

19. If your college allows minority students to take reduced course loads what proportion of minority students in the 1975-76 academic year took a reduced load:

    Freshman: Sophomore:
    Junior: Senior:

20. Have you found that majority students take reduced course loads in the same proportion as minority students? Please explain.

In general, academic, personal and financial pressures are such that a greater number of minority students carry a reduced load. Majority students do take reduced loads for some of the same reasons, but the proportion of those who do are less. No different policy; students with weaker backgrounds tend to take lighter loads than average; stronger students take heavier loads—therefore differences due more to background than load policies.

21. Have you found that permitting minority students to take reduced course loads significantly contributes to their chances of completing the degree program?

Definitely. No. Depends on the student. It gives them time to adjust to the academic rigors. No evidence of significant contribution. More important than the number of units is the number of "heavy" courses a student takes. In general, there is a greater tendency among minority students, particularly those doing poorly, to carry a much greater load than they are capable of completing satisfactorily. For students in at least the first two years, it is an important means of overcoming background weaknesses in adjusting to pace.

22. If your college or university provides compensatory or remedial courses for students who may need them, please describe the course offerings.

Math, Chemistry, Physics, Communication Skill. English. High school drafting.

23. If there are special learning laboratories, self-paced instruction reading and other skills instruction or any other non-traditional forms of teaching (not mentioned in the answer to the previous question) available to minority students, please describe them.

Special Learning Skills Laboratory. Developmental Reading Course and Reading Clinic. Learning Resources Lab provides tutoring, speed reading, how to study courses, etc. Self-paced courses.

24. What evidence do you have that the provisions in questions 22 and 23 have improved the academic performance of minority students at your college?

Detailed studies have not been made to determine effectiveness. Impossible to attain the normal starting point in required courses without these "bridging courses". Understanding and confidence are improved in special instruction and tutoring arrangements. Lower attrition rate in later calculus courses. Without a control group we cannot fully assess the improvement. Increase in GPA index. Too soon to tell.

25. Do you feel that summer school is an effective element of a retention program? *Yes—19 schools No—6 schools N/A—8 schools*

A. Do you provide financial aid for minority students who attend summer school? *Yes—17 schools No—8 schools N/A—8 schools*

B. What percentage of the minority engineering students currently enrolled attended summer school last year? *29% (22 schools) 11—N/A.*

26. For the 1974-75 school year what percentage of your students were on academic probation or warning?

	Freshman	N/A	Sophomore	N/A	Junior	N/A	Senior	N/A
Minority Students	*21% (19 sch.)*	*14*	*27% (19 sch.)*	*14*	*20% (17 sch.)*	*16*	*17% (19 sch.)*	*14*
All Students	*11% (13 sch.)*	*20*	*12% (14 sch.)*	*19*	*10% (14 sch.)*	*19*	*8% (13 sch.)*	*20*

RETENTION AND SUPPORTIVE SERVICES

27. What form of academic and personal counseling do you have for the minority student?

A. No special provisions: All students have same services	*11 schools*
B. Minority program staff	*21 schools*
C. Engineering faculty members	*20 schools*
D. University counselors	*23 schools*
E. Upperclassmen or peer counselors	*23 schools*
F. Campus health unit	*11 schools*

G. Other *Engineering guidance counselor, minority engineering club, professional counselors, College Tutoring Program, recent minority engineering graduates.*

28. If one or more of the above have been more effective than the others, please list

Minority Program Staff—13 schools
Engr. Faculty members—5 schools
Upperclassmen (Peers)—5 schools
Professionals—1 school
College Tutoring Program—1 school

29. What forms of tutoring are available for minority students?

A. Minority upperclassmen *26 schools*
B. Minority graduate students *14 schools*
C. Tutoring by fraternities or honor societies *13 schools*
D. Engineering faculty members *19 schools*
E. Professional engineers *3 schools*
F. Other *Learning Resource Laboratory, Majority Grad Students, Study Skills and Tutorial Services, College Tutoring Program, Minority Engineering Society*

30. If one or more of the above have been more effective than the others, please list below.

Minority upperclassmen—9 schools
Majority Grad Students—1 school
Minority graduate students—1 school
College tutoring program—1 school
Faculty members—2 schools

31. What proportion of minority students typically utilize the tutoring that is made available? (Please check)

	Freshman	Sophomore	Junior	Senior
Tutoring is mandatory	*5 schools*	*None*	*None*	*None*
More than 50%	*4 schools*	*7 schools*	*1 school*	*1 school*
More than 25%	*12 schools*	*11 schools*	*7 schools*	*6 schools*
Less than 25%	*6 schools*	*3 schools*	*17 schools*	*17 schools*
No Answer Not Applicable	*6 schools*	*7 schools*	*8 schools*	*9 schools*

32. Do you have a special room available as a tutoring/study room for minority engineering students?

Yes—17 schools *No—11 schools* *N/A—5 schools*

33. A. What mechanisms do you use to determine whether a minority student is encountering academic difficulty before the end of the semester?

Tutoring referral slip issued by faculty member. Mid-term grade reports. Referrals from instructors and other students. Six-weeks progress reports. Monitoring of grades during the semester.

B. After the identification of academic problems, what measures are used to assist the minority student in overcoming that difficulty? *Reduce course load. Students must attend tutoring sessions. Counseling.*

34. A. Does your school have projects or classes to provide an orientation or exposure for minority students to engineering related industry?

Yes—24 *No—7* *N/A—2*

B. If so, what effect has it had on their academic performance or morale for remaining in engineering? *Unknown at this time. Same as for white students—good. Very good. No specific data are available although it appears to improve motivation. Cooperative education has been most effective.*

35. Does the school of engineering have any provision for on-going career guidance and development after enrollment for:

A. All Students

B. Minority Students

C. Does it appear that the student participation in the career guidance activities has led to a greater commitment to remaining in the engineering college:

36. A. What proportion of the minority students on the average work at part time jobs or work study while attending school?

51% (includes co-op) 23 schools

B. What percentage of minority students working are employed in fields directly related to engineering? *30.7% (13 schools)*

C. Have you noticed any effect on the academic performance and retention of those students who work? Please explain. *The effect is mixed. No effect observed for the good students, but the poorer students have some difficulty academically if they work while attending school. Those students working in non-engineering related jobs. Those working in engineering departments on campus seem to do very well. Positive effects only—students while working on Co-op become more self-assured and enthusiastic about their studies. Positive and negative effects tend to cancel each other. Students who work generally take a reduced course load and accumulate hours slower but they persist in engineering to a higher degree than students who do not work.*

37. Have you found that on-going work experiences (co-op, summer work, etc.) have given minority students a more positive attitude toward their engineering studies? *Yes—29 schools N/A—4 schools*

A. If the reaction is different than that demonstrated by majority students, explain how. *No difference.*

38. Do the minority engineering students have a minority engineering organization? *Yes—21 schools No—8 schools N/A—4 schools*

Do the minority students in engineering have access to a university-wide minority student organization?

What effects (positive/negative) have you observed on academic performance because of the existence of these organizations?

Too involved in political aspects of the association rather than concentrating on career objectives. Very positive effect because interaction/exposure with chapters at other schools gives strong peer support/motivation. Provides group identity. Opportunity to share problems; give study reinforcement, and gain confidence. None. Provide tutoring services and morale boosters.

39. Do you think that greater participation of the minority students in the student chapters of the professional engineering societies would have a positive impact upon their retention in your college? Please explain.

Yes. This would expose students early to the aspects of interacting with majority students, as well as studying with others that are doing well. Student chapters provide a mechanism for learning what is going *on in industry and engineering beyond their courses. Being able to understand and identify more closely with a professional field should be helpful. I doubt it. No. Minority students participate and hold office to the same degree as non-minority students.*

40. How much interaction do minority students experience in studying/working with the majority students outside of the classroom?

Somewhat less than desirable. Depends upon individual student. Minimal. As much as the majority students. Moderate. A great deal.

41. What kind of effect does the large/small amount of interaction have on minority student grades? Please explain. *A negative effect, however this cannot be satisfactorily measured. Minimal. The small amount of interaction does cause them to feel a bit alienated. Since minority students get much attention from peers and staff, this is no particular problem. Adversely affects grades.*

42. Please describe the efforts of the faculty and administrators in engineering and the university toward assisting the minority students at your institution.

The faculty and administration are available for counselng and tutoring. Faculty volunteers have assisted with tutoring. Faculty members, dean, and President of the University participate extensively in national and regional minority engineering organizations. Financial aid and scholarships especially for minorities. Flow of information among counselors, admissions, instructors, and administration has been smooth and helpful. The engineering administration is receptive to implementing programs which will aid the students if we secure the funds for operation and no legal problems will occur.

43. Please check the responsibilities of the minority program staff:

A. Total/partial responsibility for admissions decisions
B. Personal counseling
C. Academic advising
D. Directing other minority program staff members
E. Fund raising for the program
F. Coordinating tutoring program
G. Total/partial responsibility for deciding financial aid awards for minority students
H. Recruiting minority student
I. Chief Administrator for summer programs
J. Approve course selection of freshman/sophomore students
K. Represent minority student interest in faculty meetings
L. General administrative duties
M. Assist students in finding summer jobs
N. Advisor for minority student organization

O. Other
P. Other

44. How many total or part-time paid staff members (administrators, counselors, advisors) have responsibilities for the minority program?

Full Time:
Part-Time:

45. Do you think that the retention rate of your minority students would increase if you could provide more supportive services (counseling, tutoring, study rooms, administrative staff, etc.)?

Yes: No:

B. If so, estimate the additional resources and services needed to provide the ideal supportive program. Describe the ideal program in detail. *An academic year program for middle school and high school students. More administrative staff. Well funded counseling and tutoring center. More counselors. Reading specialist. Student advisors (junior and senior engineering students) work with freshman and sophomore students. Five to one ratio in a "big brother" role. Availability of about 40 additional scholarships. Engineering related summer jobs. Additional facilities and capabilities that are needed are space and technical services to provide a concentrated, coordinated tutoring program. Larger number of black faculty and students. Increase the out-reach efforts during the year. Expanded summer programs. Expand contacts and experiences of teachers and counselors in high schools.*

46. If your minority program has been in existence for longer than three years, what changes have you undertaken to maintain/establish success for the program which directly address the problems of retention?

Special housing program for all students entering the College of Engineering has helped to improve retention. Peer counseling and tutoring. Development of program has been a steady evolutionary process—Although all components were in existence from outset, most have been substantially refined. Close tie-in to PRIME. Improve the academic level of the entering minority student through more rigorous recruiting and selection. Maintain personal contact with all students. Provided more tutors, strengthened the structure of the student organization, developed a better working relationship with the faculty, and developed a working relationship with industry. Developed more flexibility in first year curriculum. The position of Director of Minority Affairs was created. Identification and greater use of minority professionals to act as role models.

Engineering Colleges Surveyed† and Visited for Retention Study

University of Texas/Austin*
University of Houston*
New Jersey Institute of Technology

Texas A&M
Oklahoma State University
University of Kansas

New Mexico State University
Purdue University
Wayne State University
General Motors Institute
University of Southern California*
Michigan State University
University of Michigan/Ann Arbor
Cal State/Long Beach*
Pratt Institute
Cal State/Northridge
University of Tennessee/Knoxville*
UCLA*
Illinois Institute of Technology
Polytechnic Institute/N.Y.*
Cal State/L.A.
Cal State/Pomona**
Northeastern University**
Carnegie-Mellon University
Drexel University
University of Pennsylvania
City College of New York*
Prairie View A&M*
Southern University
N.C. A&T State University*
Howard University
University of Texas/El Paso
University of Illinois/Chicago
Tuskegee Institute*
Tennessee State University
Vanderbilt University**
University of the Pacific**
Notre Dame**
University of Arizona**
Northwestern
University of New Mexico**
University of Illinois/Urbana**
University of Alabama**
University Texas A&I**

* Campus Visit Only

** Questionnaire B Only

† Questionnaire B